WATER-WORKS EMPLOYING SYSTEM OF PUMPING TO DISTRIBUTING RESERVOIRS.

CALIFORNIA.

MARYSVILLE:

Population: 4,321 inhabitants.
Name of corporation: Marysville Water Company (private).
Water obtained from: Two artesian wells. Well No. 1, 80 feet deep, 12-inch bore; well No. 2, 150 feet deep, 12 inch bore.
Water first introduced: September, 1859.
Sizes of distributing mains: 12 to 2 inches.
Total length of distributing mains: 8 miles.
Number of water-takers: 700.
Consumption of water: 800,000 gallons per day in summer, 300,000 gallons per day in winter (estimated).
First cost of water-works: $200,000.
Average annual cost of maintenance and repairs: $1,800.
Number of fire-plugs: 12.
Design and dimensions of pumps and water-plungers: 1 Laswell, Marysville, pump, plunger 7 inches diameter, 35 strokes per minute; 1 Worthington No. 4 New York pump, plunger 14 inches diameter, 60 strokes per minute.
Time pumps are run: 5 to 12 hours per day.
Description of force-main: Head on pumps, 52 feet.
Description of water-valves: Solid rubber.
Kind of power used: Steam.
Description of boilers: 54 inches diameter, 16 feet long; fuel, wood.
Description of engine: Condensing low-pressure; 10 inches diameter, 14 inches stroke; globe valves.
Cost of engine and pumps: $8,000.

SAN DIEGO:

Population: 2,637 inhabitants.
Name of corporation: San Diego Water Company (private).
Water obtained from: San Diego river.
Water first introduced: In 1873.
Description of reservoirs: Settling reservoir, capacity, 80,000 gallons; storage reservoir, capacity, 800,000 gallons; distributing reservoir, capacity, 44,000 gallons; all walled with rock and cement.
Size of distributing mains: 5 inches.
Available head: 200 feet (average).
Total length of distributing mains: 8 miles.
Number of water-takers: 225.
Consumption of water: 85,000 gallons per day in summer, 40,000 gallons per day in winter (estimated).
First cost of water-works: $76,937 62.
Average annual cost of maintenance and repairs: $5,000.
Number of fire-plugs: 4.
Design and dimensions of pump and water-plunger: Hooker pump, by Garretts & Co., San Francisco, California; plain plunger, 36 inches stroke, 8 inches diameter, 28 strokes per minute.
Time pump is run: 11 hours per day.
Description of force-main: ½ mile long; 220 feet head on pumps.
Description of water-valves: Vulcanized spring, 8- and 4-inch.
Kind of power used: Steam.

SAN DIEGO—Continued.

Description of boilers: Tubular, 4 by 15 feet; 40 tubes; 40 pounds pressure; fuel, wood.
Description of engine: Simple, 14 inches diameter, 28 inches stroke; 42 single strokes per minute; slide-valves.
Cost of engine: $3,000.
Duty of engine: 1,315,000 pounds daily.

COLORADO.

CAÑON CITY.

Population: 1,501 inhabitants.
Name of corporation: Cañon City Water Company (private).
Water obtained from: Arkansas river.
Capacity of receiving reservoir: 1,000,000 gallons.
Cost of dam: $3,500.
Water first introduced: January, 1881.
Description of distributing reservoir: Capacity, 1,000,000 gallons; on an elevation of 140 feet above town.
Sizes of distributing mains: 10, 8, and 6 inches.
Available head: 140 feet (average).
Total length of distributing mains: Over 3 miles.
Number of water-takers: 120.
First cost of water-works: $45,000.
Filtering system: Well, 30 by 100 feet, 12 feet deep; natural gravel formation.
Number of fire-plugs: 15.
Design of pump: Knowles pump, Boston, August, 1880; 30 strokes per minute.
Time pump is run: 4 hours per day.
Kind of power used: Water.
Character and dimensions of water-wheels: Two 48-inch-turbine, Whitney's, Leominster, Massachusetts; 11 feet head.

TRINIDAD:

Population: 2,226 inhabitants.
Name of corporation: The Trinidad Water-Works Company (private).
Water obtained from: Well.
Cost of dam: $8,000.
Water first introduced: October, 1879.
Description of main conduit: 300 feet long, 2 feet wide, 3 feet high; laid in stone and covered with cap-stones.
Discharging capacity: 2,000,000 gallons per 24 hours, under 6 feet head.
Description of distributing reservoir: Rectangular; 150 by 250 feet, 16 feet deep; bottom paved with round stones and grouted with cement and concrete; sides paved with flat stones in regular courses 8 inches thick; joints filled with cement.
Sizes of distributing mains: 12, 10, 8, 6, and 4 inches.
Available head: 120 feet (average).
Total length of distributing mains: 26,800 feet.
Number of water-takers: 250.
Consumption of water: 90,000 gallons per day (exactly).
First cost of water-works: $70,000.
Average annual cost of maintenance and repairs: $1,500.
Number of fire-plugs: 30.

TRINIDAD—Continued.
Design and dimensions of pump and water-plungers: Pump made by Cope and Maxwell Manufacturing Company, Hamilton, Ohio; two plain plungers, 30 inches stroke, 10 inches diameter, 40 strokes per minute; pump-barrel, 11 inches diameter.
Time pump is run: 10 hours per day.
Description of force-main: Length 5,500 feet, diameter 12 inches; head, 310 feet on pump.
Description of water-valves: Rubber; 8 inches diameter, 1 inch lift.
Kind of power used: Steam.
Description of boilers: Steel; 24 by 4 feet; four 8- and two 10-inch flues; fuel, gas or coking-coal.
Description of engine: Compound non-condensing; 16 inches diameter, 22 inches stroke, 40 strokes per minute; slide-valves.
Cost of engine: $8,000.

DELAWARE.

NEW CASTLE:
Population: 3,700 inhabitants.
Name of corporation: New Castle Water-Works (private).
Character and dimensions of dam: 200 feet long, 8 feet high; made of stone and earth.
Water first introduced: In 1870.
Description of main conduit: 4 miles long, 10 inches diameter; cast iron.
Capacity of distributing reservoir: 1,000,000 gallons.
Sizes of distributing mains: 10, 8, 6, and 4 inches.
Available head: About 40 pounds (average).
Total length of distributing mains: About 6 miles.
Number of water-takers: About 300.
Consumption of water: 100 gallons per capita daily (estimated).
First cost of water-works: About $100,000.
Average annual cost of maintenance and repairs: About $500.
Number of fire-plugs: 35.
Design of pump: Blake pump, 25 strokes per minute.
Time pump is run: 80 hours per week.
Time spent in repairs: About 40 hours per year.
Description of force-main: 1¼ mile long; 40 pounds head on pump.
Description of water-valves: Made of gum.
Kind of power used: Steam.
Description of engine: Non-condensing; 25 strokes per minute.
Cost of engine: About $4,000.
Remarks: Water has some sediment, but pronounced by chemists not to be detrimental to health.

WILMINGTON:
Population: 42,478 inhabitants.
Name of corporation: Wilmington Water-Works (municipal).
Water obtained from: Brandywine before it reaches tide-water.
Water first introduced: November, 1827.
Description of distributing reservoirs: Low-service, capacity 3,500,000 gallons; high-service, capacity 2,000,000 gallons.
Sizes of distributing mains: 30, 20, 16, 12, 10, 8, 6, and 4 inches.
Available head: 140 to 240 feet.
Total length of distributing mains: 272,694 feet.
Number of water-takers: 4,344.
Consumption of water: 81 gallons per head daily.
First cost of water-works: $874,566 60.
Average annual cost of maintenance and repairs: $25,193 36.
Number of fire-plugs: 470.
Design and dimensions of pumps and plungers: Worthington 1872 pump, 12 strokes per minute; Knowles 1880 pump, 50 strokes per minute; Jonval turbine bucket-plunger, 11½ inches diameter.
Time spent in repairs: 100 hours per year.
Description of force-main: 1,600 feet long, 30 inches diameter; 57 pounds pressure; Knowles pump, 55 pounds pressure; 12-inch main.

WILMINGTON—Continued.
Kind of power used: Steam and water.
Character and dimensions of water-wheel: One Geyelin-Jonval turbine, 14 feet head and fall, 18 revolutions per minute; 3 gallons of water used to lift 1 to reservoir.
Fuel used: Cumberland coal used for fuel, from George's creek.
Description of engines: Worthington duplex, 11 strokes per minute; Knowles' simple.
Cost of engines: Worthington, $37,000; high service, $4,500; water-power, $6,000.
Duty of engines: 7,000,000 pounds daily.

GEORGIA.

ROME:
Population: 3,877 inhabitants.
Name of corporation: Rome Water-Works (municipal).
Water obtained from: Well.
Water first introduced: In 1871.
Description of distributing reservoir: Built on a hill 100 feet above city level; 25 feet diameter, 63 feet high; made of boiler-iron.
Sizes of distributing mains: 10 to 4 inches.
Available head: 150 feet (average).
Total length of distributing mains: 5 miles.
Number of water-takers: 350.
Consumption of water: 150,000 gallons per day (estimated).
First cost of water-works: $100,000.
Average annual cost of maintenance and repairs: $2,500.
Number of fire-plugs: 55.
Design and dimensions of pump and water-plungers: Pump, Noble Brothers & Co., Rome, Georgia; bucket-plungers, 42 inches stroke, 14 inches diameter; 15 strokes per minute; diameter of pump-barrel, 14 by 42 inches.
Time pump is run: 8 hours per day.
Time spent in repairs: 60 hours per year.
Description of force-main: 200 feet head on pump.
Description of water-valves: Brass and leather.
Kind of power used: Steam.
Description of boilers: 4 feet, 26 inches; 2 flues; fuel, bituminous coal, 1 pound to 100 gallons water.
Description of engine: Simple; 20 inches diameter, 42 inches stroke, 14 strokes per minute; slide-valves, by eccentric.
Cost of engine: $12,000.

ILLINOIS.

DE KALB:
Population: 1,598 inhabitants.
Style of corporation: Municipal.
Water obtained from: Well.
Capacity of receiving reservoir: 60,000 gallons.
Water first introduced: In 1877.
Available head in main conduit: 55 feet (average).
Sizes of distributing mains: 6 and 4 inches.
Available head in the town: 50 to 75 feet.
Total length of distributing mains: 7,000 feet.
Number of water-takers: 62.
Consumption of water: 12,000 gallons per day (estimated).
First cost of water-works: $32,000.
Average annual cost of maintenance and repairs: $1,500.
Number of fire-plugs: 13.
Design and dimensions of water-plungers: Two plain plungers, 10 inches diameter, 10 inches stroke, 40 strokes per minute; size of pump-barrel, 10 inches diameter.
Time spent in repairs: 60 hours per year.
Description of force-main: 4,000 feet long; 60 feet head on pump.
Kind of power used: Wind and steam.
Description of boilers: 42 inches diameter; 80 pounds pressure; made by Chicago Boiler Works.
Description of engine: Non-condensing, simple; 10 inches diameter, 12 inches stroke, 140 strokes per minute.
Cost of engine: $2,000.

LOCKPORT:
Population: 1,679 inhabitants.
Name of corporation: Lockport Artesian Well Company (private).
Water obtained from: Artesian well.
Cost of dam: $6,000.
Water first introduced: In 1876.
Size of distributing mains: 4 inches.
Available head: 100 feet (average).
Total length of distributing mains: 1 mile
Number of water-takers: 40.
First cost of water-works: $6,000.
Average annual cost of maintenance and repairs: $200.
Number of fire-plugs: 10.
Design and dimensions of pump and water-plunger: Pump made by Hart, Ball & Hart, Buffalo, New York; plunger, 3 inches diameter, 3 feet stroke, 50 strokes per minute.
Time pump is run: 10 hours per day.
Kind of power used: Water.

QUINCY:
Population: 27,268 inhabitants.
Name of corporation: Quincy Water-Works Company (private).
Water obtained from: Mississippi river.
Water first introduced: August, 1873.
Description of distributing reservoirs: Two tanks; aggregate capacity, 180,000 gallons; one has frost-proof jacket, but during winter of 1880–'81, with thermometer at 30° below zero no ice formed in either.
Sizes of distributing mains: 16 to 6 inches.
Available head in the town: 50 feet (average).
Total length of distributing mains: About 7 miles.
Number of water-takers: 254.
Consumption of water: 400,000 gallons per day (estimated).
First cost of water-works: $115,000.
Average annual cost of maintenance and repairs: $4,500.
Number of fire-plugs: 77.
Design and dimensions of pump: McGowan Pump Company, Cincinnati, Ohio; piston-pump; 60 strokes per minute; pump-barrel, 24 by 10 inches.
Time pump is run: 9½ hours per day.
Description of force-main: 1 mile long, 16 inches diameter; 90 pounds pressure.
Description of water-valves: 4 vulcanized-rubber disks, 12 inches diameter, ¼ inch lift.
Kind of power used: Steam.
Description of boilers: Tubular; 6 feet long, 5 feet diameter; 48 flues, 4 inches diameter each; 60 pounds pressure; fuel, bituminous coal.
Description of engine: Non-condensing, cutting off at ⅞ stroke; cylinder, 18 inches diameter; 60 strokes per minute; globe valves.
Cost of engine: $1,500.
Duty of engine: 20,000,000 pounds daily (average).
Remarks: Water impure only during floods, then only from earth and sand sediments.

INDIANA.

ATTICA:
Population: 2,150 inhabitants.
Name of corporation: City Water-Works (municipal).
Water obtained from: Springs.
Total area of water-shed available: 1½ acre.
Water first introduced: In 1868.
Description of distributing reservoir: Built of sandstone, laid in cement; roofed over; capacity, 55,000 gallons.
Sizes of distributing mains: 8 to 3 inches.
Available head: 150 feet (average); water-supply sometimes deficient.
Total length of distributing mains: 5 miles.
Number of water-takers: 250.

ATTICA—Continued.
Consumption of water: About 55,000 gallons per day (estimated).
First cost of water-works: $40,000.
Average annual cost of maintenance and repairs: $1,500.
Number of fire-plugs: 212.
Design and dimensions of pump and water-plungers: Pump made by Dear Bros., Indianapolis, Indiana; 2 plain plungers, 5 inches diameter, 9 inches stroke, 70 strokes per minute.
Time pump is run: 7 hours per day.
Description of force-main: 150 feet long, 4 inches diameter; 35 pounds pressure on pump.
Description of water-valves: Rubber; size 5 inches, ¼ inch lift.
Kind of power used: Steam.
Description of boilers: No. 1, 42 inches diameter, 10 feet long, 38 3-inch tubes; No. 2, 44 inches diameter, 12 feet long, 9 6-inch tubes.
Description of engine: Ordinary slide-valves; 70 strokes per minute.
Cost of engines: $3,100.

FORT WAYNE:
Population: 26,880 inhabitants.
Name of corporation: Fort Wayne Water-Works (municipal).
Water obtained from: Creek.
Total area of water-shed available: 8 square miles.
Dimensions of dam: 50 feet long.
Cost of dam and reservoir: Reservoir, etc., about $40,000; dam, $1,500.
Water first introduced: December, 1880.
Description of distributing reservoir: Oval; 148 by 208 feet at top, 62 by 112 feet at bottom, 34 feet deep; capacity, 3,611,310 gallons; embankment, 12 feet wide at top; inner slope, 2 to 1; faced with brick, 8 inches thick, laid in cement; exterior slope, 1½ to 1; built of clay.
Sizes of distributing mains: 4,091 feet, 24 inches; 1,991 feet, 20 inches; 5,166 feet, 16 inches; 2,776 feet, 12 inches; 3,140 feet, 8 inches; 82,141 feet, 6 inches; 9,979 feet, 4 inches.
Total length of distributing mains: 25.98 miles.
Number of water-takers: 1,600.
Consumption of water: 700,000 gallons per day (estimated).
First cost of water-works: $275,000.
Average annual cost of maintenance and repairs: $7,000.
Filtering apparatus: Basin made by widening the channel of creek, so as to form a settling basin; area, 1 acre, with banks protected by levee.
Number of fire-plugs: 212.
Design and dimensions of pump and water-plungers: Pump made by Holly Manufacturing Company; plain plungers, four 11 inches diameter, 27 inches stroke; two 10 inches diameter, 24 inches stroke; 24 strokes per minutes; pump-barrel, 11 by 27 inches.
Time pump is run: 24 hours per day.
Description of force-main: 4,200 feet, 24 inches diameter; 2,000 feet, 20 inches diameter; 2,560 feet, 16 inches diameter; 166 feet head, or 60 pounds pressure on pumps.
Description of water-valves: Rubber; 6 inches diameter, ¼ inch lift.
Kind of power used: Steam.
Description of boilers: Four tubular; 4½ by 16 feet, with 64 4-inch flues; fuel used, Hocking Valley coal.
Description of engine: Non-condensing, condensing, or compound at will; 19 inches diameter, 27 inches stroke, 24 strokes per minute; slide- and puppet-valves; injection-condenser; single-acting vertical air-pumps.
Cost of engine: $30,500.
Duty of engine: 50,000,000 pounds, daily average; 70,000,000 foot-pounds guaranteed.
Remarks: The disadvantages of direct pumping to mains principally are unequal motion of engines, constant attention necessary, and comparative expensiveness.

LA FAYETTE:
Population: 14,860 inhabitants.

LA FAYETTE—Continued.
Style of corporation: Municipal.
Water obtained from: Wabash river.
Cost of dam: $67,000.
Water first introduced: May, 1876.
Description of main conduit: Diameters, 24 and 16 inches; head, 235 feet (average).
Description of distributing reservoir: Located on upper level of city; its bottom is 208 feet above low water; dimensions, 60 by 120 feet at bottom, 190 by 250 feet at top; slope, 1½ to 1; capacity, 4,500,000 gallons.
Sizes of distributing mains: 16, 12, 10, 8, and 4 inches.
Available head: 100 to 150 feet; water-supply sometimes deficient.
Total length of distributing mains: 19 miles.
Number of water-takers: 600.
Consumption of water: 600,000 gallons per day (estimated).
First cost of water-works: $300,000.
Average annual cost of maintenance and repairs: $11,500.
Number of fire-plugs: 167.
Design and dimensions of pump and water-plungers: Pump made by Clapp & Jones, Hudson, New Jersey; 2 plain plungers, 9⅜ inches diameter, 36 inches stroke, 35 strokes per minute; pump-barrel, 9⅛ by 36 inches.
Time pump is run: 10 hours per day, 5 days per week.
Description of force-main: 2 miles long, 16 inches diameter; 211 feet head, or 45 pounds pressure on pump.
Description of water-valves: Rubber.
Kind of power used: Steam.
Description of boilers: Steel; 26 feet long, 44 inches diameter; 40 pounds pressure; fuel, slack coal.
Description of engine: Condensing, flat ball-valve; operated by screw.
Cost of engine: $27,000.
Duty of engine: 30,000,000 foot-pounds, daily average.

NEW ALBANY:
Population: 16,423 inhabitants.
Name of corporation: New Albany Water Company (private).
Water obtained from: Ohio river.
Capacity of receiving reservoirs: 3 reservoirs; total capacity, 9,000,000 gallons.
Character and dimensions of dam: Made of clay, lined with brick two layers thick, each layer 6 inches thick; solid puddle-bank, sodding on outside.
Cost of dam: $20,000.
Water first introduced: July, 1876.
Description of main conduit: 4,200 feet long, 16 inches diameter; cast iron.
Discharging capacity: 3,000,000 gallons per day; head, 198 feet (average).
Description of distributing reservoir: Made partly by excavation and partly by embankment; slope, 1½ to 1; banks, clay-puddled; 15 feet deep.
Sizes of distributing mains: 12, 10, 8, and 6 inches.
Available head: 175 to 220 feet.
Total length of distributing mains: 17 miles.
Number of water-takers: 700.
Consumption of water: 500,000 or 600,000 gallons per day (estimated).
First cost of water-works: $175,000.
Average annual cost of maintenance and repairs: $6,000.
Number of fire-plugs: 146.
Design and dimensions of pump and water-plungers: Pump made by F. Shefold, New Albany; two plain plungers; 16 inches diameter, 5 feet stroke, 12 to 14 strokes per minute; pump-barrel, 17 inches.
Time pumps are run: 50 hours per week.
Description of force-main: 4,282 feet long; 270 feet head on pump.
Description of water-valves: 4½ inches diameter, 3 inches lift.
Kind of power used: Steam.

NEW ALBANY—Continued.
Description of boilers: Two 46 inches diameter, 26 feet long; two 17-inch flues, 80 pounds pressure; 10 pounds of water to 1 pound of coal; fuel, Pittsburgh coal.
Description of engine; high-pressure, non-condensing; 26 inches diameter, 6 feet stroke, 12 to 14 strokes per minute; puppet-valves worked by eccentric.
Cost of engine: $15,000.
Duty of engine: 4,187,000 gallons per 100 pounds coal daily; 2,000,000 gallons per day guaranteed.

KENTUCKY.

MAYSVILLE:
Population: 5,220 inhabitants.
Name of corporation: Maysville Water Company (private).
Water obtained from: Ohio river.
Capacity of receiving reservoir: 2,500,000 gallons.
Cost of dam: $20,000.
Water first introduced: In 1880.
Description of main conduit: Iron.
Description of distributing reservoir: Built on hill-side; half excavation and half embankment; base embankment, 18 inches puddle; core, 4-inch brick wall.
Sizes of distributing mains: 14, 12, 10, 8, 6, and 4 inches.
Available head: 340 feet (average).
Total length of distributing mains: 7 miles.
Number of water-takers: 204.
First cost of water-works: $160,000.
Number of fire-plugs: 70.
Design of pump: Pump made by Blake Manufacturing Company, Boston, Massachusetts, 1880.
Description of force-main: 5,000 feet long, 12 inches diameter; 150 pounds pressure on pump.
Kind of power used: Steam.
Description of boilers: Four boilers; two batteries, 26 feet long, 48 inches diameter.
Cost of engine: $30,000.

NEWPORT:
Population: 20,433 inhabitants.
Name of corporation: Newport Water-Works (municipal).
Water obtained from: Ohio river.
Capacity of receiving reservoir: 45,000,000 gallons.
Character and dimensions of dam: 35 feet high, 20 feet wide on top; slopes, 1½ to 1 and 3 to 1.
Cost of dam: $141,000.
Water first introduced: In 1873.
Description of main conduit: 13,450 feet long, 20 inches diameter; cast iron; head, 174 feet (average).
Description of distributing reservoir: Constructed by dam across two ravines.
Sizes of distributing mains: 16, 10, 8, 6, and 4 inches.
Available head: 132 to 207 feet.
Total length of distributing mains: 16½ miles.
Number of water-takers: 1,583.
Consumption of water: About 20½ gallons per head daily (estimated).
First cost of water-works: $615,000.
Average annual cost of maintenance and repairs: $650.
Number of fire-plugs: 107.
Design and dimensions of pump and water-plunger: Pump made by Cope & Maxwell Manufacturing Company, Hamilton, Ohio, 1873; plain plunger, double-acting, 13 inches diameter, 4 feet stroke, 14 strokes per minute; pump-barrel 18 inches by 5 feet.
Time pump is run: 14 hours per day.
Description of force-main: 1,600 feet long, 24 inches diameter; 350 feet head on pump.
Description of water-valves: Rubber; 14 inches diameter, 1¼ inch lift.
Kind of power used: Steam.
Description of boilers: Two; 24 feet long, 40 inches diameter; 80 pounds pressure; fuel, bituminous coal.

NEWPORT—Continued.
Description of engine: Non-condensing, direct-acting; 26 inches diameter, 4 feet stroke, 14 strokes per minute; slide-valves.
Cost of engine: $12,500.

PLEASANT HILL:
Population: 203 inhabitants.
Style of corporation: Municipal.
Water obtained from: Springs.
Capacity of receiving reservoir: 5,000 gallons.
Description of distributing reservoir: Built of cedar, black locust, and mulberry staves, banded with iron; capacity, 5,000 gallons.
Sizes of distributing mains: 2, 1½, 1, and ¼ inches.
Total length of distributing mains: 1 mile.
Number of water-takers: 200.
Consumption of water: 250 gallons per day (estimated).
First cost of water-works: $3,000.
Average annual cost of maintenance and repairs: $50.
Design and dimensions of pump and water-plungers: Pump made by Burnett, Cincinnati, Ohio, 1832; two plain plungers, 4 inches diameter, 4 strokes per minute; pump-barrel, 4 inches diameter.
Time pump is run: 8 hours per day.
Description of force-main: ¼ mile long, 3 inches diameter; cast iron; 120 feet head on pump.
Description of water-valves: 2½ inches diameter.
Kind of power used: Horse.

MAINE.

BIDDEFORD:
Population: 12,651 inhabitants.
Name of corporation: Saco Water-Power Company (private).
Water obtained from: Saco river.
Capacity of receiving reservoir: 252,000 gallons.
Character and dimensions of dam: Of granite, where water is taken.
Cost of dam: $20,000.
Description of main conduit: Cast iron; diameter, 12 inches; head, 85 feet (average).
Description of distributing reservoir: Built on eminence, 85 feet above pumps; granite lined with brick and cement; roofed over.
Sizes of distributing mains: 12, 8, and 6 inches.
Available head: 50 feet (average); water-supply seldom deficient.
Fire-plugs: Made by Saco Water-Power machine-shops.
Design of pumps: Fales and Jenk rotaries; W. P. Crocker's twin rotary.
Time pumps are run: Constantly.
Kind of power used: Water.

LEWISTON:
Population: 19,083 inhabitants.
Name of corporation: City Water-Works (municipal).
Water obtained from: Androscoggin river.
Character and dimensions of dam: Owned and maintained by the Union Water-Power Company.
Cost of dam: $38,824 71.
Water first introduced: In 1878.
Description of main conduit: 2,556 feet long, 24 inches diameter; cast iron.
Description of distributing reservoir: Situated about 2 miles from pumping-station; 200 feet elevation; core of embankment, brick and cement; capacity, 14,000,000 gallons.
Sizes of distributing mains: 24 to 4 inches.
Available head: 54 to 110 pounds.
Total length of distributing mains: About 22 miles.
Number of water-takers: 2,788.
Consumption of water: About 1,000,000 gallons per day; 52 gallons per head.
First cost of water-works: $500,000.

LEWISTON—Continued.
Average annual cost of maintenance and repairs: About $5,000.
Filtering apparatus: Built in arch leading from head-gates to screen-well; area (superficial), 400 feet; sea-gravel and sand 32 inches deep; cleaned once a week.
Number of fire-plugs: 141.
Design and dimensions of pump and water-plungers: Pump made by H. R. Worthington, Brooklyn, New York; 4 plain plungers, 17¼ inches diameter, 38 inches stroke, 9 strokes per minute; pump-barrel, 26 inches diameter.
Time pump is run: 222 days in 1880.
Description of force-main: 24 inches diameter; 92 pounds head on pump.
Description of water-valves: Hard rubber; 7 inches diameter, ⅛ to ¾ inch lift.
Kind of power used: Water.
Description of water-wheels: Two Risden turbine; 54 inches; 25 feet head; 80 revolutions per minute.

MASSACHUSETTS.

DANVERS:
Population: 6,598 inhabitants.
Name of corporation: Danvers Water-Works (municipal).
Water obtained from: Middleton and Swan ponds.
Total area of water-shed available: 2,089 acres.
Area of receiving reservoirs: Middleton pond, 106 acres; Swan pond, 69 acres.
Water first introduced: In 1876.
Description of distributing reservoir: Oval, 21 feet deep, nearly vertical walls; owned by state of Massachusetts; capacity, 5,000,000 gallons.
Sizes of distributing mains: 12, 8, 6, and 4 inches.
Available head: 230 feet (average).
Total length of distributing mains: 28½ miles.
Number of water-takers: 1,000.
First cost of water-works: $180,000.
Average annual cost of maintenance and repairs: $4,000.
Number of fire-plugs: 184.
Design and dimensions of pump and water-plungers: Pump, made by H. R. Worthington, New York; 2 plain plungers, 16 inches diameter, 26 inches stroke, 52 strokes per minute.
Time pump is run: 1,800 hours per year.
Description of force-main: 13,879 feet long, 12 inches diameter; 56 to 80 pounds pressure on pump.
Description of water-valves: Worthington's patent.
Kind of power used: Steam.
Description of boilers: Tubular; 16 feet long, 5 feet 4 inches diameter, 56 pounds pressure; fuel used, anthracite furnace coal.
Description of engine: Duplex compound condensing; high-pressure cylinder 21 inches diameter, low-pressure cylinder 43 inches diameter, 26 inches stroke, 52 strokes per minute; balanced slide-valves, each operated by piston of other engine; Worthington's air-pump.
Duty of engine: 56,000,000 to 60,000,000 foot-pounds daily, (average); 50,000,000 foot-pounds guaranteed.
Remarks: Only in one instance has any impurity of water been noticed.

KINGSTON:
Population: 1,524 inhabitants.
Name of corporation: Kingston Aqueduct Association (private).
Water obtained from: Spring, mill privilege.
Water first introduced: In 1804.
Description of main conduit: ½ mile long, 1¼ inch diameter: lead.
Description of distributing reservoir: 20 feet high; stands on a hill; pump at base of hill, 60 feet below stand-pipe.
Size of distributing mains: 1¼ inch.
Total length of distributing mains: ½ mile.
Number of water-takers: 48.
First cost of water-works: $2,500.

KINGSTON—Continued.
Design and dimensions of water-plunger: Single-acting plunger, 3½ inches in diameter, 10 to 18 strokes per minute; pump-barrel, 3½ inches diameter.
Time pump is run: Constantly.
Description of force main: 60 feet head on pump.
Description of water-valves: Plunger-valves, 1¼ inch diameter.
Kind of power used: Water.
Character and dimensions of water-wheel: Overshot, 5½ feet diameter, 8 feet head; 10 to 80 revolutions per minute.

LINCOLN:
Population: 907 inhabitants.
Name of corporation: Lincoln Water-Works (municipal).
Water obtained from: Sandy pond.
Total area of water-shed available: 300 acres.
Area and capacity of receiving reservoir: Pond, 152 acres; 1,300,000 gallons.
Water first introduced: October, 1875.
Description of main conduit: Diameter, 8 inches; wrought iron and cement.
Description of distributing reservoir: Puddled earth; capacity, 1,300,000 gallons.
Size of distributing mains: 6 inches.
Available head: 20 to 80 feet.
Total length of distributing mains: About 3½ miles.
Number of water-takers: 20.
First cost of water-works: About $33,000.
Number of fire-plugs: 11.
Design of pump and water-plungers: Made by H. R. Worthington, New York.
Time pump is run: About 20 hours per week.
Description of force-main: 6,400 feet long, 6 inches diameter; 160 feet head on pump.
Kind of power used: Steam.
Description of boilers: Fuel, anthracite coal.
Description of engine: Simple; 10 inches diameter, 145 strokes per minute.
Cost of engine: $2,500.

LYNN:
Population: 38,274 inhabitants.
Name of corporation: Lynn Water-Works (municipal).
Water obtained from: Streams.
Total area of water-shed available: 1.57 square mile.
Area and capacity of receiving reservoirs: First pond, 63.18 acres, 226,310,942 gallons; second pond, 69.6 acres, 211,491,976 gallons.
Character and dimensions of dams: No. 1, 300 feet long; earthwork, 23 feet high, 15 feet wide on top; slopes, 1½ to 1; puddled clay on inside; retaining-wall on outside, 150 feet long, 18 feet high. No. 2, 250 feet long, 16 feet high, 15 feet wide on top; slope, 1½ to 1; earthwork, with puddle-clay wall through center.
Cost of dams: $75,595.
Water first introduced: In 1871.
Description of main conduit: 2,228 feet long, 18 inches diameter; 5,833 feet long, 22 inches diameter; wrought iron and cement.
Discharging capacity: About 4,000 gallons per minute; head, 17 feet (average).
Description of distributing reservoir: Built on a side hill, partly excavated and partly embankment; inside slopes and bottom puddled with clay; capacity, 20,000,000 gallons; 15 feet deep; water-surface, 177 feet above datum; a 12-inch slope-wall on rubble backing (15 inches thick) on the outside.
Sizes of distributing mains: 16 to 2 inches.
Available head: 150 feet (average).
Total length of distributing mains: 56⅝ miles.
Number of water-takers: 6,753.
Consumption of water: 1,238,289 gallons per day, 49.4 per consumer, 32.3 per inhabitant, exact, in 1880.
First cost of water-works: $1,000,390.
Average annual cost of maintenance and repairs: $9,500.

LYNN—Continued.
Number of fire-plugs: 411.
Design and dimensions of pump and water-plunger: Pump designed by E. D. Lavitt, jr., built by I. P. Morris & Co., Philadelphia; one bucket-plunger, 18⅛ inches diameter, 7 fee stroke; piston-valve, 22 and 16½ inches diameter, 18½ strokes per minute; pump-barrel, 26 1/10 inches diameter, 7 feet stroke.
Time pump is run: 2,190 hours per year.
Description of force-main: 1,904 feet long; 166 feet head on pump.
Description of water-valves: Cornish, double-beat; 15⅞ inches diameter of lower seat outside, 10 inches diameter upper seat inside; 2¼ inches lift.
Kind of power used: Steam.
Description of boilers: Horizontal tubular, 16 feet long, 5 feet diameter; 72 3-inch tubes; drum, 6 feet high, 3 feet diameter; 8.58 pounds to 1 pound coal; fuel, anthracite coal.
Description of engine: Compound condensing; high-pressure cylinder 17½ inches diameter, low-pressure cylinder 36 inches diameter, 7 feet stroke, 18.5 strokes per minute; gridiron slide-valves, worked by cams; jet-condenser; air-pump, double-acting, 11¼ inches diameter, 49½ inches stroke.
Cost of engine and pump: $50,000.
Duty of engine: 92,843,506 foot-pounds daily (average); 70,000,000 foot-pounds guaranteed.
Remarks: One pond in summer is tainted by a smell of animal matter, rendering it unfit for domestic use.

SOMERVILLE:
Population: 24,933 inhabitants.
Style of corporation: Municipal.
Water obtained from: Boston water-works.
Water first introduced: In 1876.
Available head: 6 to 130 feet; water-supply sometimes deficient.
Total length of distributing mains: 45 miles.
Number of water-takers: 4,683.
First cost of water-works: $342,608 76 (cost of distribution).
Average annual cost of maintenance and repairs: $8,000.
Number of fire-plugs: 278 (see accompanying report on Boston, p. 17–31).

WALTHAM:
Population: 11,712 inhabitants.
Name of corporation: Waltham Water-Works (municipal).
Water obtained from: Charles river.
Total area of water-shed available: About 200 square miles.
Area and capacity of receiving reservoir: 61,917 square feet; 6,000,000 gallons.
Water first introduced: In 1873.
Description of main conduit: 2,629 feet long, 16 inches diameter; wrought iron lined with cement.
Description of distributing reservoir: Built in natural gorge; puddled dams at ends, oval in shape; ends semicircles, 105 feet radius, joined by straight walls 50 feet long; slopes, 1½ to 1; inner slope lined with granite 12 inches through.
Sizes of distributing mains: 16, 12, 10, 8, 6, 4, and 2 inches.
Available head: About 135 feet (average).
Total length of distributing mains: 23.33 miles.
Number of water-takers: 1,557.
Consumption of water: 411,000 gallons per day (average).
First cost of water-works: $223,000.
Filtering apparatus: Basin, ¼ acre, 8½ feet deep, 30 feet from bank of Charles river; gravel; no cleaning.
Number of fire-plugs: 152.
Design and dimensions of pumps and water-plungers: Two pumps, made by H. R. Worthington, New York, in 1873 and 1880; two plain double-acting plungers, 14 inches diameter, 18 inches stroke, 45 strokes per minute.
Time pumps are run: 14 hours per day, 5 days per week.
Time spent in repairs: 12 hours per year (average).
Description of force-main: 2,600 feet long, 16 inches diameter. 164 feet head on pumps.

WALTHAM—Continued.

Description of water-valves: Rubber, weighted on gridiron seats; 6¼ inches diameter, ¼-inch lift.
Kind of power used: Steam.
Description of boilers: Horizontal return-tubular; 16 feet long, 5 feet diameter; 55 pounds pressure (average); fuel used, hard coal.
Description of engine: Compound condensing; high-pressure cylinder 14 inches diameter, low-pressure cylinder 24 inches diameter, 18 inches stroke, 90 strokes per minute; globe-valves, operated by wheel and spindle; 4 air-pumps, 9 by 13½ inches; jet-condenser, 16 by 22 inches.
Cost of engine and pumps: $17,150.
Duty of engine: 45,000,000 foot-pounds guaranteed.

MISSOURI.

SAINT JOSEPH:

Population: 32,431 inhabitants.
Name of corporation: Saint Joseph Water Company (private).
Water obtained from: Missouri river.
Water first introduced: December, 1880.
Description of distributing reservoir: Three basins; middle basin used as a subsiding reservoir; water from main received in well, whence it passes into middle or either basin or into mains direct; capacities, subsiding basin, 2,000,000 gallons; south district basin, 4,000,000 gallons; north district basin 6,000,000 gallons.
Sizes of distributing mains: 20, 16, 12, 10, 8, 6, and 4 inches.
Available head: 116 to 314 feet.
Total length of distributing mains: 24 miles.
Number of water-takers: 134.
Consumption of water: 600,000 gallons per day (estimated).
First cost of water-works: $700,000.
Filtering system: Use subsiding basin.
Number of fire-plugs: 184.
Design and dimensions of pumps and water-plungers: Two pumps, made by H. R. Worthington, Brooklyn, New York, in 1880–'81; main engine, two plungers, 17½ inches diameter, 36 inches stroke, 58 strokes per minute; diameter of pump-barrel, 17½ inches; auxiliary engine, two plungers, 10 inches diameter, 15 inches stroke, 138.8 strokes per minute; diameter of pump-barrel, 10 inches.
Description of force-main: 1,196 feet long, 16 inches diameter. 127 pounds pressure on pumps.
Description of water-valves: 64 rubber; 4-inch opening, ¼ inch lift.
Kind of power used: Steam.
Description of boilers: 3 tubular; 59 4-inch tubes; shell, 64 inches diameter, 16 feet long; fuel used, semi-bituminous coal.
Description of engine: Compound condensing; cylinders 25 and 13.3 inches diameter, 36 and 38 inches stroke, 58 strokes per minute; balanced slide-valves, worked from rock-shaft; spray-condenser; four air-pumps, 18¾ inches diameter, 15 inches stroke.
Cost of engine and pumps: $30,000.

NEW HAMPSHIRE.

NASHUA:

Population: 13,397 inhabitants.
Name of corporation: Pennichucks Water-Works (private).
Water obtained from: Small stream.
Total area of water-shed available: About 30 square miles.
Character and dimensions of dams: One wood and stone, 15 feet fall; one stone, 17 feet fall; use water for power twice (two pumping-houses).
Water first introduced: In 1855.
Description of distributing reservoir: Capacity, 1,500,000 gallons.
Sizes of distributing mains: 16 to 4 inches.
Available head: 100 feet (average).
Total length of distributing mains: About 20 miles.

NASHUA—Continued.

Number of water-takers: 1,021.
Consumption of water: 1,000,000 gallons per day (estimated).
First cost of water-works: $60,000.
Average annual cost of maintenance and repairs: About $10,000.
Number of fire-plugs: 55.
Design and dimensions of pump and water-plunger: Old pump removed in 1881, and Lang's substituted; made at Burlington, Vermont; plain plunger, 12 inches diameter, 28 inches stroke, 24 strokes per minute; pump-barrel, 12 inches diameter.
Time pump is run: Constantly.
Description of force-main: 5,200 feet long; head on pump, 132 feet.
Description of water-valves: Lang's patent.
Kind of power used: Water; steam in case of drought.
Description of water-wheels: 1 Jonval turbine, 15 feet head, 94 revolutions per minute; 10 gallons of water used to lift 1 gallon to reservoir; 2 Swain wheels to Lang pump, 24 feet head, 200 revolutions per minute, 8 gallons used to lift 1 gallon to reservoir.
Description of boilers: Hinkley's patent locomotive boiler; 65 pounds pressure; fuel, hard coal.
Description of engine: Cylinder, 14 by 36 inches; 60 strokes per minute; puppet-valve, worked by bevel-gear.
Cost of engine and pumps: $14,500.
Duty of engines: 1,000,000 gallons in 24 hours; 3,000,000 gallons in 24 hours guaranteed.

NEW JERSEY.

BRIDGETON:

Population: 8,722 inhabitants.
Style of corporation: Municipal.
Water obtained from: East Lake pond (Cedar Swamp-water).
Water first introduced: December, 1877.
Description of distributing reservoir: Area, 135 feet square; clay banks lined with brick; slope, 1½ to 1; capacity, 1,350,000 gallons.
Sizes of distributing mains: 16 and 2 inches.
Available head: 15 to 40 pounds.
Total length of distributing mains: 11½ miles.
Number of water-takers: 540.
Consumption of water: 108,000 gallons per day (average).
First cost of water-works: $69,000.
Average annual cost of maintenance and repairs: $1,445.
Number of fire-plugs: 77.
Design and dimensions of pump and water-plungers: Worthington, 1877, Brooklyn, New York; two plain plungers, 13 inches diameter, 18 inches stroke, 55 strokes per minute; pump-barrel, 13 inches diameter.
Time pump is run: 807 hours per year in 1880.
Description of force-main: 2,300 feet long, 16 inches diameter; 87 feet head on pump (average).
Description of water-valves: Rubber, 6 inches diameter, ¼ inch lift.
Kind of power used: Steam.
Description of boilers: Tubular, 12 feet long, 42 inches, diameter; 45 pounds pressure; fuel used, hard coal.
Description of engine: Compound duplex; high-pressure cylinder 14¼ inches diameter, low-pressure cylinder 30 inches diameter, 18 inches stroke, 55 strokes per minute; D slide-valve with cut-off at ¼ inch stroke; two air-pumps, 10 inches bore, 12 inches stroke; jet condenser.
Cost of engine and pump: $10,500.

CAPE MAY:

Population: 1,699 inhabitants.
Style of corporation: Municipal.
Water obtained from: Wells.
Capacity of receiving reservoir: 40,000 to 60,000 gallons.

CAPE MAY—Continued.
Water first introduced: In 1876.
Description of main conduit: Diameters, 12, 10, and 8 inches; cast iron; 20 pounds pressure.
Sizes of distributing mains: 12, 10, and 8 inches.
Total length of distributing mains: 3 miles.
Number of water-takers: 200.
Consumption of water: 100,000 gallons per day (estimated).
First cost of water-works: $5,000.
Number of fire-plugs: 65.
Design and dimensions of pump and water-plunger: R. D. Wood & Co., Millville, New Jersey; plain plunger 20 inches diameter, 65 inches stroke, 65 strokes per minute; pump-barrel, 24 by 16 inches.
Time pumps is run: 24 hours four months; 7 hours eight months.
Description of force-main: 20 pounds pressure on pump.
Kind of power used: Steam.
Description of boilers: Upright; 60 inches diameter, 6 feet flues; fuel, pea-coal.
Description of engine: Simple; 65 strokes per minute; common globe-valves.
Cost of engine and pump: $1,900.
Duty of engine: 400 gallons per minute daily guaranteed.

JERSEY CITY:
Population: 120,722 inhabitants.
Name of corporation: Jersey City Water-Works (municipal).
Water obtained from: Passaic river.
Total area of water-shed available: 981 square miles.
Water first introduced: In 1853.
Description of main conduit: 6¼ miles long, 36 and 24 inches diameter; cast iron and cement.
Sizes of distributing mains: 36 and 26 inches.
Available head: 30 to 90 feet.
Total length of distributing mains: About 13.5 miles.
Consumption of water: 80 gallons per head (estimated).
Design of pumps and water-plungers: 3 Cornish and 3 Worthington.
Kind of power used: Steam.

MOUNT HOLLY:
Population: 4,621 inhabitants.
Name of corporation: Mount Holly Water Company (private).
Water obtained from: Rancocas river.
Capacity of reservoirs: 2 basins, 250,000 gallons each.
Cost of dam: $30,000.
Water first introduced: In 1851.
Description of main conduit: Diameter, 6 inches; iron.
Description of distributing reservoir: 2 basins; about 101 feet above tide-water; puddled clay and brick walls.
Size of distributing mains: 6 inches.
Available head: 40 to 90 feet.
Total length of distributing mains: 1,800 feet.
Number of water-takers: About 310.
Consumption of water: 168,000 gallons per day (estimated).
First cost of water-works: $24,000.
Average annual cost of maintenance and repairs: About $2,000.
Number of fire-plugs: 29.
Design and dimensions of pumps and water-plungers: One plain horizontal pump, plunger 6 inches diameter, 3 feet stroke, 30 strokes per minute; one Worthington duplex pump, plunger 10 inches diameter, 18 inches stroke, 66 strokes per minute.
Time pumps are run: 4 hours per week.
Time spent in repairs: None; apparatus duplicate.
Description of force-main: 1,800 feet long; 41 pounds pressure (standing) and 60 pounds pressure (running) on pumps.
Description of water-valves: Rubber (small spring).
Kind of power used: Steam.
Description of boilers: 1 Harrison, 20 horse-power; 1 tubular, 14 feet long, 40 inches diameter.

MOUNT HOLLY—Continued.
Description of engines: 1 condensing; 1 non-condensing; high-pressure 12 inches diameter, 18 inches stroke, low pressure 24½ inches diameter; 66 strokes per minute on condensing engine; plain slide-valves; air-pump, 8-inch bore, 18 inches stroke; jet-condenser, 12 inches diameter, 36 inches long.
Cost of engines and pumps: $14,000.
Duty of engines: 200,000 gallons against 60 pounds pressure, with 900 pounds coal daily.

PASSAIC:
Population: 6,532 inhabitants.
Name of corporation: Acquackanouck Water Company (private).
Water obtained from: Passaic river.
Capacity of reservoir: About 1,000,000 gallons.
Water first introduced: In 1872.
Description of distributing reservoir: Area 10 feet diameter, 7½ feet deep.
Sizes of distributing mains: 8 and 6 inches.
Total length of distributing mains: About 9 miles.
Number of water-takers: 250.
Consumption of water: 250,000 gallons per day (estimated).
Average annual cost of maintenance and repairs: $8,498 17.
Number of fire-plugs: 83.
Design and dimensions of pump and water-plunger: Pump made by C. Carr, Trenton, New Jersey; one plain plunger, 12 inches diameter, 5 feet stroke, 14 strokes per minute; pump-barrel, 3 inches diameter.
Time pump is run: 10 or 12 hours per day.
Description of force-main: 5,831 feet long, 12 inches diameter; 45 pounds head on pump.
Description of water-valves: 4 side-buckets, 12 by 18 inches diameter, 8 inches lift.
Kind of power used: Steam.
Description of boilers: Tubular; 16 feet long, 50 pounds pressure; fuel, stove and nut coal.
Description of engine: Simple; cylinder 11 inches diameter, 3 feet stroke, 60 strokes per minute; slide-valves.
Cost of engine and pump: About $8,000.

PATERSON:
Population: 51,031 inhabitants.
Name of corporation: Passaic Water Company (private).
Water obtained from: Passaic river.
Capacity of reservoir: 18,000,000 gallons.
Character and dimensions of dam: Stone and timber, 4 feet high; total head and fall on turbine wheel, 28 feet.
Water first introduced: In 1857.
Description of distributing reservoirs: One with stone wall inside, earth outside; two built with clay puddle-wall and clay bottom, paved on inside.
Sizes of distributing mains: 20, 16, 12, 10, 8, 6, and 4 inches.
Available head: 25 pounds (average); water-supply sometimes deficient.
Total length of distributing mains: About 40 miles.
Number of water-takers: 2,635.
Consumption of water: 110 gallons per head per day.
First cost of water-works: $800,000.
Average annual cost of maintenance and repairs: $12,000.
Number of fire-plugs: 480.
Design and dimensions of pumps and plungers: Paterson Steam Engine Company, three plain single pumps, double-acting, 6 feet stroke; H. R. Worthington, New York, one duplex, 18 inches stroke; all cylinders are 18 inches diameter, 12 to 15 strokes per minute.
Time pumps are run: 23 hours per day.
Time spent in repairs: 1 hour per day (average).
Description of force-main: 700 feet long, 16 inches diameter; 600 feet long, 16 inches diameter, 68 feet head on pumps; 110 feet long, 12 inches diameter, 30 pounds pressure on pumps.
Description of water-valves: Rubber: 1st, 12 inches diameter, ¾ inch lift; 2d, 6 inches diameter, ¾ inch lift.

PATERSON—Continued.

Kind of power used: Steam and water.

Description of water-wheels: Built by Stout, Mills, & Temple, Dayton, Ohio; one 54 inches diameter, 8 feet head, 64 revolutions per minute; one 48 inches diameter, 28 feet head, 135 revolutions per minute; 10 gallons of water required to lift one gallon to reservoir (average).

Description of boilers: Two horizontal tubular, 15 feet long; 46 3-inch tubes; fuel, egg-coal.

Description of engine: Condensing; 24 inches diameter, 4 feet stroke, 40 strokes per minute; Hewes' patent valves; surface condenser.

Cost of engine and pumps: $40,000.

Remarks: Water pronounced very pure by silk-dyers, who require the best.

TRENTON:

Population: 29,910 inhabitants.

Name of corporation: Trenton Water-Works (municipal).

Water obtained from: Delaware river above tide-water.

Cost of dam: $15,000.

Water first introduced: In 1855.

Description of distributing reservoir: Open reservoir.

Sizes of distributing mains: 16 to 2 inches.

Available head: 6 to 85 feet.

Total length of distributing mains: 35 miles.

Number of water-takers: About 5,000.

Consumption of water: 1,250,000 gallons per day (estimated).

First cost of water-works: $100,000.

Average annual cost of maintenance and repairs: $8,830.

Filtering apparatus: 60 by 100 feet area; tile at bottom; 4 layers of gravel, each layer diminishing 1 foot of river; sand on top; cleaned once a year.

Number of fire-plugs: 200.

Design and dimensions of pumps and water-plungers: Pumps made by William Wright, Newburg, New York, and Charles Carr, Trenton, New Jersey; bucket-plungers 16 inches diameter, 5 feet stroke, 20 strokes per minute; pump-barrel, 16 inches diameter.

Time pumps are run during the year: Wright engine and pump, 1,560 hours; Carr engine and pump, 185 hours; water-wheel and pump, 7,249 hours; total, 8,994 hours.

Time spent in repairs: 244¼ hours per year.

Description of force-main: ¾ mile long, 16 inches diameter; ¾ mile long, 10 inches diameter; 50 pounds pressure on pumps.

Description of water-valves: Wright, perpendicular; Carr, hinge.

Kind of power used: Steam and water.

Description of water-wheel: One Ohio turbine, 4 feet diameter, 14 feet head, 20 revolutions per minute; 8 gallons of water required to lift 1 gallon to reservoir.

Fuel used: Plymouth broken coal.

Description of engine: Condensing compound; high-pressure cylinder 12 inches diameter, low-pressure cylinder 16 inches diameter, 5 feet stroke each, 20 strokes per minute; Wright's automatic valves.

Cost of engine and pumps: $30,000.

Duty of engine: Capacity of Wright's engine and pump, 2,000,000 gallons in 24 hours; actual amount pumped yearly by all the pumps, 596,271,297 gallons; water-wheel pumps alone 448,930 gallons.

NEW YORK.

COHOES:

Population: 19,416 inhabitants.

Name of corporation: Cohoes Water-Works (municipal).

Water obtained from: Mohawk river.

Character and dimensions of dam: 144 feet long, 9 feet high (average); stone, capped with limestone; built diagonally across Mohawk river.

Cost of dam: $160,000.

Water first introduced: In 1859.

Description of main conduit: Diameter, 16 and 12 inches; cast iron; head, 130 to 245 feet.

COHOES—Continued.

Description of distributing reservoirs: On elevation; one built in clay soil and the other in clay and gravel; capacity, 4,000,000 and 8,000,000 gallons.

Sizes of distributing mains: 16 to 4 inches.

Available head: 130 to 240 feet.

Total length of distributing mains: About 12 miles.

Consumption of water: 30 gallons per head per day (estimated).

First cost of water-works: $160,000.

Average annual cost of maintenance and repairs: $13,000 to $15,000.

Number of fire-plugs: 135.

Design and dimensions of pumps and water-plungers: Geyelin, Philadelphia; built at Cohoes in 1858–'59 and 1868–'69; two plain plungers, 10 and 10 inches diameter, 5 and 6 feet stroke, 12 to 16 strokes per minute; pump-barrels, 10 inches by 5 feet, 16 inches by 6 feet.

Time pumps are run: Almost constantly.

Time spent in repairs: About five days per year.

Description of force-main: 1,250 feet long, 10 inches diameter; 3,400 feet long, 16 inches diameter; 20 to 70 pounds pressure on pumps.

Description of water-valves: Clack-valves.

Kind of power used: Water.

Description of water-wheels: 2 Jonval turbines, one 4 feet diameter, one 3 feet 6 inches diameter, 30 and 40 horse-power; 14 feet head; 70 revolutions per minute; 12½ gallons required to lift 1 gallon to reservoir.

Remarks: Water impure only after freshets.

HUDSON:

Population: 8,670 inhabitants.

Name of corporation: Hudson Water-Works (municipal).

Water obtained from: Hudson river.

Capacity of receiving reservoir: 4,000,000 gallons.

Water first introduced: In 1874.

Description of conduit: 7,215 feet long, 12 inches diameter; iron; head, 130 feet (average).

Description of distributing reservoir: Area at crest line, 32,696 square feet; 20 feet deep; capacity, 3,200,000 gallons.

Sizes of distributing mains: 12, 6, 4, and 3 inches.

Available head: 80 pounds (average).

Total length of distributing mains: 12⅞ miles.

Number of water-takers: 888.

Consumption of water: 830,000 gallons per day (average).

First cost of water-works: $250,000.

Average annual cost of maintenance and repairs: $10,000.

Filtering system: 13½ feet deep; area at crest, 15,081 square feet; surface of sand, 9,081 feet; stone gravel; cleaned every six weeks (average).

Number of fire-plugs: 177.

Design and dimensions of pump and water-plungers: Clapp & Jones, Hudson, New York, 1874; 2 plain plungers, 8 inches diameter, 36 inches stroke, 34 strokes per minute; pump barrel, 36 by 8 inches.

Time pump is run: 12 hours per day (average).

Time spent in repairs: 1 hour per day (average).

Description of force-main: 7,215 feet long; 311.9 feet head on pump.

Description of water-valves: Rubber; made by Clapp & Jones.

Kind of power used: Steam.

Description of boilers: Tubular; 16 by 5½ feet; 40 pounds pressure, 8 pounds by 1 pound coal; fuel, Pittston coal.

Description of engine: Condensing; 36 by 25 inches, 34 strokes per minute; slide-valves; jet-condenser, 15 by 26 inches; lifting-pump.

Cost of engine and pump: $34,000.

Duty of engine: 77,000,000 foot-pounds daily; 50,000,000 foot-pounds guaranteed.

LYONS:

Population: 3,820 inhabitants.

Name of corporation: Rawley Water-Works (private).

Water obtained from: Springs.

LYONS—Continued.
Description of reservoir: Large cistern, 40 by 60 feet, 12 feet deep.
Cost of dam: $3,500.
Water first introduced: September, 1878.
Description of main conduit: 1,200 feet long; head, 70 feet (average).
Sizes of distributing mains: 4, 2, and 1½ inches.
Available head: 70 feet (average).
Total length of distributing mains: About 7,000 feet.
Number of water-takers: 36.
Consumption of water: 3 to 20 barrels per day.
First cost of water-works: About $3,500.
Average annual cost of maintenance and repairs: $300.
Design and dimensions of pump and water-plungers: Made by M. V. B. Rowley; double-acting 2-cylinder, 40 to 60 strokes per minute; pump-barrel, 2 and 4 by 7 inches.
Kind of power used: Wind-mill.

OSWEGO:
Population: 21,116 inhabitants.
Name of corporation: Oswego Water Company (private).
Water obtained from: Oswego river.
Water first introduced: In 1869.
Description of distributing reservoirs: Two in embankment; no puddling, faced with riprap; eastern, 325 by 600 feet, 15 feet deep; slope, 1 to 1; western, nearly rectangular, 500 by 700 by 225 by 275 feet; area, 4.922 acres; depth, 15 feet; cobblestone and sand division-wall in reservoirs for filtration.
Sizes of distributing mains: 8, 6, 4, and 3 inches.
Total length of distributing mains: 16 miles.
Number of water-takers: 600.
Consumption of water: 1,000,000 gallons per day.
First cost of water-works: $462,500.
Average annual cost of maintenance and repairs: $27,300.
Number of fire-plugs: 167.
Design and dimensions of pumps and water-plungers: Two made by H. Storer, New York, in 1869; two plain piston plungers to each, 10½ inches diameter, 3 feet stroke, 56 strokes per minute.
Time pumps are run: Constantly.
Description of force-mains: Western reservoir, two cast-iron pipes, one 8 inches and the other 10 inches diameter, each 1,450 feet long; eastern reservoir, one 4,100 feet long, 10 inches diameter, and one 3,600 feet long, 8 inches diameter; 300 feet head on pumps, each.
Description of water-valves: Two square rubber flap, 5½ by 7 inches, at each end of the pump-cylinders, each ⅞ inch thick; free lift.
Kind of power used: Water.
Description of water-wheels: Two Storer patent, 5 feet diameter, 3 feet high, 14½ feet head, 56 revolutions per minute.

PEEKSKILL:
Population: 6,893 inhabitants.
Name of corporation: Peekskill Water-Works (municipal).
Water obtained from: Oscawana lake.
Total area of water-shed available: 30,000 acres.
Capacity of receiving reservoir: 31,000,000 gallons.
Character and dimensions of dam: Small one across stream leading from lake; logs and earth, with sheathing boards, to give elevation to stream to drive wheels.
Cost of dam: $24,721 25.
Water first introduced: In 1872.
Description of main conduit: 221 feet square flue; wood; head, 15 feet (average).
Description of distributing reservoir: Excavated and riprapped on sides, excepting north side, which has dam; clay and puddle trench and riprapped.
Sizes of distributing mains: 12 to 4 inches.
Available head: 110 to 120 pounds.
Consumption of water: 200,000 gallons (estimated).
First cost of water-works: $136,150.

PEEKSKILL—Continued.
Averaeg annual cost of maintenance and repairs: About $1,680.
Number of fire-plugs: 76.
Design and dimensions of pump and water-plunger: Flander's patent, made by Vergennes Machine Company, Vermont, 1873–'74; one plain plunger, 11 1/16 inches diameter, 16 feet stroke, 24 strokes per minute.
Time pump is run: 10 hours per day.
Time spent in repairs: 5 days per year.
Description of force-main: ¾ mile long, 12 inches diameter; 155 pounds pressure on pump.
Kind of power used: Water.
Description of water-wheels: Two American turbines, made by Stout, Mills, & Temple; 48 inches and 36 inches diameter; 34 gallons of water required to lift 1 gallon to reservoir.

WEST TROY:
Population: 8,820 inhabitants.
Name of corporation: West Troy Water-Works Company (private).
Water obtained from: Mohawk river and surface-water.
Total area of water-shed available: 700 acres.
Area and capacity of reservoir: 10 to 12 acres; 70,000,000 gallons.
Character and dimensions of dams: 1,200 feet long, made of stone, riprapped, with timber frame and plank sheathing; head, 7 feet; reservoir dam; 250 feet breadth at base, 50 feet high; earth.
Available head: 110 to 120 pounds.
Cost of dams: $250,000.
Water first introduced: In 1877.
Description of main conduit: 16 inches diameter; wrought iron, cement-lined inside and out; head, 180 feet (average).
Description of distributing reservoir: It is a natural ravine.
Sizes of distributing mains: 16 and 4 inches.
Available head: About 160 feet (average).
Total length of distributing mains: 14 miles.
Number of water-takers: About 270.
Consumption of water: 1,000,000 gallons per day (estimated).
First cost of water-works: $250,000.
Number of fire-plugs: 100.
Design and dimensions of pumps and water-plunger: Flander's pump, made at Vergennes, Vermont; 2 cylinders, double-acting; 16 strokes per minute (average); pump-barrel, 14 inches diameter.
Time pump is run: 11 months per year.
Description of main conduit: ½ mile long; 59 pounds pressure on pump.
Kind of power used: Water.
Description of water-wheels: American turbine, 72 inches diameter, made by Stout, Mills, & Temple, Dayton, Ohio; 6 feet head, 17 revolutions per minute.
Remarks: Water a little hard, on account of rocky bed over which it flows.

OHIO.

BELLAIRE:
Population: 8,025 inhabitants.
Name of corporation: City Water-Works (municipal).
Water obtained from: Ohio river.
Character and dimensions of dam: One across front of reservoir; stone wall filled and puddled, 23 feet from river bed.
Water first introduced: In 1872.
Description of distributing reservoir: Semi-circular, with dam across front; excavated in side hill; capacity, 3,000,000 gallons.
Sizes of distributing mains: 12 to 3 inches.
Available head: 65 pounds (average).
Total length of distributing mains: 9 miles.
Number of water-takers: 1,200.
Consumption of water: 578,835 gallons per day (estimated).
First cost of water-works: $100,000.
Average annual cost of maintenance and repairs: About $4,000.
Number of fire-plugs: 75.

BELLAIRE—Continued.
Design and dimensions of pump and water-plungers: Made by Hobbs, Taylor, & Co., Wheeling, West Virginia; four plain plungers, 12 inches diameter, 12 strokes per minute; pump-barrel, 12 by 48 inches.
Description of force-main: 1,475 feet long, 12 inches diameter; 104 pounds pressure on pump.
Description of water-valves: Iron with leather seat; 12 inches diameter, 2 inches lift.
Kind of power used: Steam.
Description of boilers: One tubular, 14 feet long, 48 inches diameter; 60 3-inch flues; fuel, finest slack.
Description of engine: High-pressure; 18 inches diameter, 30 inches stroke, 40 strokes per minute; globe-valves.
Duty of engine: 3,898,150 foot-pounds daily.
Remarks: Oil-refinery in Wheeling City makes water impure at low water.

EAST LIVERPOOL:
Population: 5,568 inhabitants.
Name of corporation: East Liverpool Water-Works (municipal).
Water obtained from: Ohio river.
Capacity of reservoir: 2,500,000 gallons.
Cost of dam: $6,000.
Water first introduced: November, 1880.
Description of distributing reservoir: 116 feet square on top, 68 feet square on bottom, 23 feet deep; made partly by excavation and partly by embankment of guard work; lined with brick and cement.
Sizes of distributing mains: 10, 8, 6, and 4 inches.
Available head: 100 to 265 feet; water-supply sometimes deficient.
Total length of distributing mains: About 5 miles.
Number of water-takers: 450.
First cost of water-works: $36,000.
Average annual cost of maintenance and repairs: $5,000.
Number of fire-plugs: 40.
Design and dimensions of pump and water-plungers: Made by Maxwell Manufacturing Company, Hamilton, Ohio, 1879; two plain plungers, 10 inches diameter, 3 feet stroke, 20 strokes per minute; pump-barrel 10 inches diameter.
Time pump is run: 8 hours per day, 4 days per week.
Description of force-main: 900 feet long.
Description of water-valves: Gum; 4 inches diameter, 3 inches lift.
Kind of power used: Steam.
Description of boilers: Two flue; 6 flues to each.
Description of engine: Compound; 14 by 22 inches diameter, 3 feet stroke, 20 strokes per minute.
Cost of engine and pump: $6,000.
Duty of engine: 3,300,000 foot-pounds in 22 hours.

PENNSYLVANIA.

ALLEGHENY:
Population: 78,682 inhabitants.
Name of corporation: City Water-Works (municipal).
Water obtained from: Allegheny river.
Capacity of reservoir: 10,000,000 gallons.
Water first introduced: In 1848.
Description of distributing reservoir: Parallelogram in shape, with cross-section stone wall dividing it into two compartments, each containing about 5,000,000 gallons, with one influent; effluent chamber constructed at ends of division-wall.
Size of distributing mains: 20 inches.
Available head: 92 feet (average); water-supply sometimes deficient.
Total length of distributing mains: 50 miles.
Number of water-takers: 13,000.
Consumption of water: 8,000,000 gallons per day (estimated).
Average annual cost of maintenance and repairs: $30,000.

ALLEGHENY—Continued.
Design and dimensions of pumps and water-plungers: One Lowry's, designed by Hartupee, Pittsburgh, Pennsylvania; two plain plungers, 30 inches diameter, 8 feet stroke, 8 strokes per minute; pump-barrel, 30½ inches diameter; four Knapp & Tutton pumps, Pittsburgh, Pennsylvania; four double-acting piston-plungers, 12¾ inches diameter, 8 feet stroke, 16 strokes per minute; pump-barrel, 12¾ inches diameter.
Time pumps are run: Constantly.
Time spent in repairs: 600 hours per year.
Description of force-main: 580 feet long, 30 inches diameter; 215 feet head on pumps.
Description of water-valves: Lowry; disk, 15 inches diameter, 1¼ inches lift; Knapp & Tutton hinge.
Kind of power used: Steam.
Description of boilers: Four 26 feet long, 48 inches diameter; two 16-inch flues; 8 pounds of water to 1 pound of coal; fuel, bituminous coal.
Description of engines: Simple; Lowry's; 44 inches diameter, 11 feet stroke, 8 strokes per minute; balance disk-valve by ordinary gear. Knapp & Tutton's, 20½ inches diameter, 8 feet stroke, 16 strokes per minute.
Duty of engines: Lowry's, 36,000,000 foot-pounds daily.
Remarks: Water sometimes impregnated with oil.

BUTLER:
Population: 3,163 inhabitants.
Name of corporation: Butler Water-Works Company (private).
Water obtained from: Connoquenessing creek.
Water first introduced: November, 1878.
Description of distributing reservoir: Area, 121 by 121 feet bottom, 160 by 160 feet top, 18 feet high to flow-line; capacity, 2,500,000 gallons.
Sizes of distributing mains: 10, 8, and 4 inches.
Available head: 100 pounds (average).
Total length of distributing mains: 5 miles.
First cost of water-works: $49,000.
Number of fire-plugs: 41.
Design and dimensions of pump and water-plunger: Epping pump, built by Thompson, Epping, & Carpenter, Pittsburgh, Pennsylvania, 1878; one plain plunger; 9¼ inches diameter, 3 feet stroke, 24 strokes per minute; pump-barrel 9¼ inches diameter.
Time pump is run: About 3 hours per week.
Description of force-main: 2,900 feet long, 12 inches diameter, 13 pounds pressure on pump.
Description of water-valves: Puppet; brass, faced with leather, 4 by 12 inches, ⅛ inch thick, ¼ inch lift.
Kind of power used: Steam.
Description of boilers: Double-flue; 20 feet long, 38 inches diameter; flues 15 inches diameter; fuel, bituminous coal.
Description of engine: Simple; 20 inches diameter, 3 feet stroke, 48 strokes per minute; slide-valves operated with cams.
Cost of engine and pump: $5,000.
Duty of engine: 100 pounds coal raise 5,500 gallons daily (average).

CARLISLE:
Population: 6,209 inhabitants.
Name of corporation: Carlisle Gas and Water Company (private).
Water obtained from: Conedogwinit creek.
Character and dimensions of dams: Wooden; 200 feet long between abutments; meadow dam, 150 feet long.
Water first introduced: In 1854.
Description of main conduit: 1¼ mile long, 6 inches diameter; head, 52 feet (average).
Description of distributing reservoirs: Two, 120 feet square each, 11 feet deep.
Sizes of distributing mains: 8, 6, and 4 inches.
Available head: 52 feet (average).
Total length of distributing mains: 8 miles.
Number of water-takers: 510.

CARLISLE—Continued.
Consumption of water: 30 gallons per head (estimated).
First cost of water-works: About $80,000.
Average annual cost of maintenance and repairs: $200.
Number of fire-plugs: 61.
Design and dimensions of pump and water-plungers: Made by A. F. Smith, Chambersburg, Pennsylvania, 1854; two bucket-plungers, 7¼ inches diameter, 18 inches stroke, 26 strokes per minute; pump-barrel 8 feet high, 24 inches diameter.
Time pump is run: Constantly.
Description of force-main: 1¼ mile long, 6 inches diameter; 40 pounds pressure on pump.
Description of water-valves: Ordinary check; 8 inches diameter, 1¼ inch lift.
Kind of power used: Water.
Description of water-wheel: One turbine; 56 inches diameter (*Leffel turbine*), *4 feet head, 26 revolutions per minute.*
Remarks: Sometimes, after heavy rains and sudden thaws, the water is muddy.

CHESTER:
Population: 14,997 inhabitants.
Name of corporation: South Ward Water-Works of Chester (municipal).
Water obtained from: Delaware river.
Capacity of reservoir: 1,500,000 gallons.
Water first introduced: In 1868.
Sizes of distributing mains: 12, 10, 8, 6, and 4 inches.
Available head: 40 pounds (average).
Total length of distributing mains: 15 miles.
Number of water-takers: 1,600.
Consumption of water: 300,000 gallons per day (estimated), or 20 gallons per head.
First cost of water-works: $84,000.
Average annual cost of maintenance and repairs: $8,000.
Number of fire-plugs: 64.
Design and dimensions of pump and water-plungers: Made by Robert Wetherill & Co., Chester, Pennsylvania, in 1879; 2 plain plungers, 9¼ inches diameter, 30 inches stroke, 47 strokes per minute.
Time pump is run: 70 hours per week.
Description of force-main: 1 mile long, 12 inches diameter; 35 to 43 pounds pressure on pump.
Description of water-valves: Rubber, 3½ inches diameter, ¾-inch lift.
Kind of power used: Steam.
Description of boilers: 2 sets, double deck; 10 feet 1½ inch long, 42 inches diameter; about 90 horse-power; fuel used, pea coal.
Description of engine: Compound condensing, 20 and 9 inches diameter, 36 inches stroke, 47 strokes per minute; Corliss valves; air-pump, jet-condenser.
Cost of engine and pump: $10,000.
Duty of engine: 800,000 gallons daily; 2,500,000 gallons in 24 hours guaranteed.

CLARION:
Population: 1,169 inhabitants.
Name of corporation Clarion Water Company (private).
Water obtained from: Clarion river.
Capacity of reservoir: 90,000 gallons.
Water first introduced: In 1875.
Description of main conduit: 1,000 feet long.
Description of distributing reservoirs: Two wooden tanks; capacity, 43,200 gallons each.
Sizes of distributing mains: 6 inches.
Available head: 69 feet (average).
Total length of distributing mains: 6,000 feet.
Number of water-takers: 127.
Consumption of water: 63 gallons per head per day (estimated).
First cost of water-works: $14,000.
Average annual cost of maintenance and repairs: $100.

CLARION—Continued.
Filtering apparatus: Made of broken stone; cleaned once a year.
Number of fire-plugs: 11.
Design and dimensions of pump and water-plunger: Eclipse pump, made by H. D. McKnight, Pittsburgh, Pennsylvania; plunger, 4 inches diameter, 3 strokes per minute; pump-barrel, 4 by 14 inches.
Time pumps are run: 3 days per week.
Description of force-main: 3,300 feet long; 210 pounds pressure perpendicular on pump; height, 525 feet.
Description of water-valves: Brass; 2 inches lift.
Kind of power used: Steam.
Description of boilers: Tubular; 100 pounds pressure; fuel, Erie City coal.
Description of engine: Simple; 9 inches diameter, 14 inches stroke, 30 strokes per minute; expansion valves.
Cost of engine and pump: $600.
Duty of engine: 2,700 gallons daily.

HARRISBURG:
Population: 30,762 inhabitants.
Name of corporation: Harrisburg Water-Works (municipal).
Water obtained from: Susquehanna river.
Water first introduced: In 1840.
Discharging capacity: 65 pounds pressure (average).
Description of distributing reservoir: Rectangular embankment, 525 by 275 feet at top, 28 feet deep; slope 1½ to 1; two divisions separated by masonry, dividing wall 14 feet high; slope, 1½ to 1; slopes puddled with concrete, stone, rip-rap; capacity, 20,000,000 gallons; stand-pipe wrought iron, 5 by 207 feet, brick tower, stone base; situated at pump-station on river.
Sizes of distributing mains: 30, 20, 16, 12, 10, 8, 6, and 4 inches.
Total length of distributing mains: 19.908 miles.
Number of water-takers: 5,000.
First cost of water-works: $600,000.
Average annual cost of maintenance and repairs: $20,000.
Number of fire-plugs: 250.
Design and dimensions of pumps and water-plungers: Two made by Harrisburg Foundery Company, 1874; plain, solid plungers, 22½ inches diameter, 5 feet stroke, 40 strokes per minute.
Time pumps are run: 14 hours per day.
Description of force-main: 15,220 feet long, 30 inches diameter; cast iron; 90 pounds pressure on pumps.
Description of water-valves: Lifting disk, 7½ inches diameter, 1 inch lift; 28 inches each pump.
Kind of power used: Steam.
Description of boilers: 16 multitubular, 16 feet long, 4 feet diameter; 26 4-inch tubes in each; 100 to 150 pounds pressure; fuel, anthracite coal.
Description of engines: Condensing, 54 inches diameter, 5 feet stroke; non-condensing, 30 inches diameter, 5 feet stroke, 40 strokes per minute; double-beat valves, by cams; jet-condenser, 4 feet long, 24 inches diameter; two air-pumps, 25 inches diameter, 2 feet stroke.
Cost of engines and pumps: $35,000.
Duty of engines: 51,000,000 foot-pounds daily (average).

KENNETT SQUARE:
Population: 1,021 inhabitants.
Style of corporation: Municipal.
Water obtained from: Springs.
Total area of water-shed available: About 6 square miles.
Capacity of reservoirs: 100,000 gallons.
Character and dimensions of dam: Covers 2 acres; fed by a race 1 mile long; used to supply pump in case spring should fail.
Cost of dam: $30,000.
Water first introduced: In 1843.
Description of main conduit: ¾ mile long, 6 inches diameter, terra cotta; ½ mile long, 6 inches diameter, iron.

KENNETT SQUARE—Continued.

Description of distributing reservoirs: No. 1, 30 feet square, 10 feet deep; capacity, 66,000 gallons. No. 2, 20 feet square, 10 feet deep; capacity, 34,000 gallons.
Sizes of distributing mains: 6, 4, 3, and 2 inches.
Available head: 10 to 100 feet; water-supply deficient only in extremely dry weather.
Total length of distributing mains: About 1½ mile.
Number of water-takers: About 250.
Consumption of water: 20,000 to 40,000 gallons per day (estimated).
First cost of water-works: $30,000.
Average annual cost of maintenance and repairs: $100 to $200.
Number of fire-plugs: 15.
Design and dimensions of pump and water-plunger: One double-acting, made by Edge F. Cope & Sons, Westchester, Pennsylvania; *plain plunger 6 inches diameter, 12 inches* stroke, 20 to 30 strokes per minute; pump-barrel, 6 by 12 inches.
Time pump is run: Constantly.
Time spent in repairs: 3 days per year.
Description of force-main: ½ mile long, 6 inches diameter; head, 85 feet on pump.
Description of water-valves: Brass; 6 inches square, on hinges; 4 inches lift.
Kind of power used: Water.
Description of water-wheel: 12 feet diameter; buckets, 4 feet long, made by E. F. Cope & Sons, Westchester, Pennsylvania; 18 feet head, 10 to 18 revolutions per minute; about 12 gallons of water required to lift 1 gallon to reservoir.

KITTANNING:

Population: 2,624 inhabitants.
Name of corporation: Kittanning Water Company (private).
Water obtained from: Allegheny river.
Water first introduced: January, 1872.
Description of distributing reservoir: Clay formation; concrete bottom, with puddled clay; 64 feet square at bottom, 110 feet square at top, 18 feet high; capacity, 1,200,000 gallons.
Sizes of distributing mains: 10, 8, and 4 inches.
Available head: 216 feet; 80 pounds (average).
Total length of distributing mains: 5½ miles.
Number of water-takers: 440.
Consumption of water: 40 gallons per head per day (estimated).
Number of fire-plugs: 26.
Design and dimensions of pump and water-plunger: Made by Epping & Carpenter, Pittsburgh, in 1875; one plain plunger, 10 inches diameter, 2 feet stroke, 28 to 30 strokes per minute; pump-barrel, 10 inches diameter.
Time pump is run: 10 hours per day.
Description of force-main: 2,300 feet long; 120 pounds pressure on pump.
Description of water-valves: 3½ by 12 inches diameter, ⅜ inch lift.
Kind of power used: Steam.
Description of boilers: Flue, 22 feet long, 38 inches diameter; 90 pounds pressure; fuel, bituminous coal.
Description of engine: Simple, non-condensing, 16 inches diameter, 2 feet stroke, 28 to 30 strokes per minute; slide-valves, operated with cams.
Cost of engine and pump: $3,500.

LANCASTER:

Population: 25,769 inhabitants.
Name of corporation: City Water-Works (municipal).
Water obtained from: Conestoga river.
Capacity of reservoirs: No. 1—2,500,000 gallons; No. 2—3,500,000 gallons.
Character and dimensions of dam: 160 feet long, 7 feet high; crib-work and stone.
Water first introduced: In 1836.
Description of distributing reservoir: Embankment, 25 feet wide, lined with brick.
Sizes of distributing main: 20, 12, 10, 8, 6, and 4 inches.

LANCASTER—Continued.

Available head: 1 to 40 feet; water-supply sometimes deficient.
Total length of distributing mains: About 33 miles.
Number of water-takers: About 3,500.
Consumption of water: 112 gallons per head per day (estimated).
First cost of water-works: $442,000.
Average annual cost of maintenance and repairs: About $10,000.
Filtering system: Gallery required, as it is necessary to distribute the muddy water as soon as pumped into the reservoir.
Number of fire-plugs: 350.
Design and dimensions of pumps and water-plungers: Steam, made by Worthington, New York, 1878; 2 water-power, by Berkenbine, and one by Geyelin, in 1869; 3 plain Berkenbine plungers; 10 inches diameter, 44 inches stroke, 23 strokes per minute; one Geyelin plunger, 10 inches diameter, 48 *inches stroke, 13 strokes per minute; pump-barrels same size* as plungers.
Time pumps are run: Steam, almost constantly; water, very seldom.
Description of force-main: 24, 12, 8, and 3 inches diameter.
Description of water-valves: Gum; 6 inches diameter, 3 inches lift.
Kind of power used: Steam and water.
Description of water-wheels: three 6-foot turbines; Berkenbine, 7 feet head, 23 revolutions per minute; Geyelin, 13 revolutions per minute.
Description of boilers: Four horse-power, tubular; 65 pounds pressure; fuel used, coal No. 1, hard pea.
Description of engine: Compound condensing; 56 strokes per minute; Worthington patent valves and condenser.
Cost of engine and pumps: Worthington, $20,000.

MEADVILLE:

Population: 8,860 inhabitants.
Name of corporation: Meadville Water Company (private).
Water obtained from: French creek.
Capacity of reservoir: 5,000,000 gallons.
Cost of dam: $22,500.
Water first introduced: September, 1875.
Description of main conduit: 160 feet long, 20 inches diameter; 4,750 feet long, 12 inches diameter; cast iron; head, 200 feet (average).
Description of distributing reservoir: 145 by 280 feet; 24 feet deep; division-wall, 12 feet high; walls, puddled clay bricked in cement.
Sizes of distributing mains: 12, 6, and 4 inches.
Available head: 250 feet (average).
Total length of distributing mains: 13¾ miles.
Number of water-takers: 700.
Consumption of water: 280,000 gallons per day.
First cost of water-works: $137,735.
Average annual cost of maintenance and repairs: $3,000.
Filtering system: 34 by 35 feet; filled with gravel; cleaned every 3 years.
Number of fire-plugs: 89.
Design and dimensions of pumps and water-plungers: One Flander's improved; one W. H. Lang; one Flander's; two plain Flander's plungers, 10 inches diameter, 20 inches stroke; Flander's improved plunger, 12 inches diameter, 30 inches stroke, 14 to 20 strokes per minute; pump-barrels, 12½ inches diameter.
Time pumps are run: Flander's, 10 hours per day.
Description of force-main: 4,500 feet long; 120 pounds pressure on pumps.
Description of water-valves: Lang's and Flander's.
Kind of power used: Water.
Description of water-wheel: One, turbine, 54 inches diameter, 15 feet head.

MOUNT JOY:

Population: 2,058 inhabitants.
Style of corporation: Municipal.
Water obtained from: Chiques Salunga creek.

MOUNT JOY—Continued.

Total area of water-shed available: 48 square miles.
Character and dimensions of dam: 80 feet wide, 5 feet fall; backing up about 1,800 feet; walled up with stone.
Cost of dam: $40,000.
Water first introduced: In 1874.
Description of main conduit: 8 inches diameter; cast iron.
Description of distributing reservoir: Capacity, 750,000 gallons; 126 feet above creek; water pumped up 86 feet above main level of town; made by excavation and embankment, lined with puddled clay and brick, 13 feet deep.
Sizes of distributing mains: 8, 6, and 4 inches.
Total length of distributing mains: 17,344 feet.
Number of water-takers: 159.
First cost of water-works: $40,000.
Average annual cost of maintenance and repairs: $500.
Number of fire-plugs: 25.
Design and dimensions of pump and water-plunger: Made by Weiner & Berkenbine, Lebanon, Pennsylvania; plain plunger, with patent water-cushions; 6 inches diameter, 2 feet stroke, 40 strokes per minute.
Time pump is run: 3 to 4 days per week.
Description of force-main: 1,000 feet long; 50 pounds pressure on pump.
Description of water-valves: Brass; 8 inches diameter, ¼ inch lift.
Kind of power used: Steam and water.
Description of water-wheel: Risten turbine; 6 feet head.
Description of boiler: 13 feet long, 3½ feet diameter; 50 to 70 pounds pressure; fuel used, soft nut coal.
Description of engine: Simple; 10 inches diameter, 18 inches stroke, 110 strokes per minute; four air-chambers, 12 inches diameter, 2 feet high.
Remarks: No impurities, except in rainy weather, when water is muddy.

NORRISTOWN:

Population: 13,063 inhabitants.
Name of corporation: The Norristown Insurance and Water Company (private).
Water obtained from: Schuylkill river.
Water first introduced: December, 1847.
Description of distributing reservoirs: One, capacity about 1,000,000 gallons; one, capacity about 10,000,000 gallons; partly excavated and partly embankment; puddled with clay and paved with bricks.
Sizes of distributing mains: 16, 12, 10, 8, 6, 4, and 3 inches.
Available head: 1st reservoir, 132 feet (average); 2d reservoir, 194 feet (average); water-supply seldom deficient.
Total length of distributing mains: 10 to 15 miles.
Number of water-takers: 2,500 to 3,000.
Consumption of water: 750,000 gallons per day (estimated).
Number of fire-plugs: 150.
Design and dimensions of pumps and water-plungers: No. 1, made by H. R. Worthington, New York; plunger, two 14-inch pistons, brass packing, 20 strokes per minute; pump-barrel, 14 by 18 inches; No. 2, made by R. S. Newbold, Norristown, Pennsylvania; one 16-inch plunger, 13 strokes per minute; pump-barrel, 16 by 60 inches; both plungers double.
Description of force-main: 1⅛ mile long, 24 inches diameter; 1st reservoir, 57 pounds pressure on pumps; 2d reservoir, 80 pounds pressure.
Description of water-valves: No. 1, rubber; No. 2, metal, leather faced.
Kind of power used: Steam.
Description of boilers: Six, 30 inches by 33 feet, plain cylinder or tubular boiler, equal to 3 of the above.
Description of engines: No. 1, compound; high-pressure cylinder 16 inches diameter, low-pressure cylinder 24 inches diameter, 18 inches stroke, 80 strokes per minute; No. 2, non-condensing, 32 inches high, 5 feet stroke, 26 strokes per minute; ordinary globe valves, by hand; 4 single 8 by 12 inches cylinder condenser.

724

OIL CITY

Population: 7,315 inhabitants.
Name of corporation: Oil City Water Company (municipal).
Water obtained from: Allegheny river.
Capacity of reservoir: 3,000,000 gallons.
Cost of dam: About $160,000.
Water first introduced: In 1872.
Description of main conduit: 12 inches diameter; iron; head, 310 feet.
Description of distributing reservoir: Excavated; two compartments, 80 by 80 feet, with berme 10 feet high; slope, 1½ to 1; total depth, 20 feet; puddled with clay and lined with brick.
Sizes of distributing mains: 12, 10, 8, 6, and 4 inches.
Available head: 80 to 120 pounds.
Total length of distributing mains: 10 miles.
Number of water-takers: About 1,000.
Consumption of water: 560,000 gallons per day or 70 gallons per head (estimated).
First cost of water-works: $160,000.
Average annual cost of maintenance and repairs: About $6,000.
Number of fire-plugs: 72.
Design and dimensions of pump and water-plunger: Made by Eclipse Pump Works, Pittsburgh, Pennsylvania, in 1872; plain plunger, 20 by 30 inches cylinder, 14 to 20 strokes per minute; pump-barrel, 12 inches diameter.
Time pump is run: 24 hours; one at a time.
Description of force-main: 1,200 feet long and 310 feet long; 130 pounds pressure on pumps.
Description of water-valves: Metal, lined with leather; 4½ by 9 inches diameter.
Kind of power used: Steam.
Description of boilers: Two; 5 by 12 feet; 62 3-inch flues; fuel, bituminous coal.
Description of engine: Simple cylinder, 2 feet diameter, 2 feet 6 inches stroke, 14 to 20 strokes per minute; round valves worked by cam-brake from cylinder.
Cost of engine and pump: $4,000.
Duty of engine: 560,000 gallons daily.
Remarks: Water is impure only in June from vegetable matter.

OXFORD:

Population: 1,502 inhabitants.
Style of corporation: Municipal.
Water obtained from: Wells.
Capacity of reservoir: 48,500 cubic feet.
Water first introduced: In 1870.
Description of main conduit: 7,260 feet long, 6 inches diameter; 6,456 feet long, 4 inches diameter; 4,689 feet long, 3 inches diameter; cast iron.
Description of distributing reservoir: 80 by 80 feet, top; 24 by 24 feet, bottom; 18 feet deep; basin lined with puddle clay and paved with bricks.
Sizes of distributing mains: 6 and 4 inches.
Available head: About 20 feet (average); water-supply sometimes deficient.
Total length of distributing mains: About 13,716 feet.
Number of water-takers: About 110.
First cost of water-works: About $40,000.
Average annual cost of maintenance and repairs: About $600.
Number of fire-plugs: 18.
Design and dimensions of pumps and water-plungers: Two; 4 plain plungers, 4 inches diameter, 2 feet stroke, 8 or 10 strokes per minute; diameter of pump-barrel, 4 inches.
Description of force-main: 4,689 feet long, 3 inches diameter.
Description of water-valves: Brass.
Kind of power used: Steam and water.
Description of water-wheel: Overshot; 11 feet diameter, 3 feet lift, 11 feet head, 8 to 10 revolutions per minute.
Description of boilers: About 4 horse-power; fuel used, anthracite coal.
Description of engine: Simple.
Duty of engine: About 20,000 gallons daily.

PARKER'S LANDING:
Population: 1,835 inhabitants.
Name of corporation: Parker's and Lawrenceburg Water Company (private).
Water obtained from: Allegheny river.
Area and capacity of reservoirs: 48,000 gallons each at three points.
Water first introduced: In 1872.
Description of main conduit: 4 inches diameter; head, 50 to 150 feet.
Description of distributing reservoirs: Wooden tankage at three points.
Size of distributing mains: 4 inches.
Available head: 40 to 80 pounds.
Total length of distributing mains: About 2 miles.
Number of water-takers: 200.
Consumption of water: 8,000 gallons per day (estimated).
First cost of water-works: $14,000.
Average annual cost of maintenance and repairs: $300.
Filtering apparatus: Tank, 8 by 12 by 5 feet, sunk in bottom of river, filled with sand and gravel.
Number of fire-plugs: 37.
Design and dimensions of pumps and water-plungers: Cameron pumps; made in 1881; 2 plain plungers; 6 inches diameter; 12 inches stroke; 35 strokes per minute; pump-barrel, 6 by 12 inches.
Time pumps are run: About 20 hours per day.
Description of force-main: ⅞ mile long; 200 pounds pressure on pumps.
Description of water-valves: Flat composition.
Kind of power used: Steam.
Description of boiler: Tubular; 40 horse-power; 75 pounds pressure; fuel, bituminous coal.
Description of engine: Non-condensing; 14 inches diameter, 12 inches stroke, 40 strokes per minute; simple globe-valves.
Cost of engine and pumps: $600 each.

PHŒNIXVILLE:
Population: 6,682 inhabitants.
Style of corporation: Municipal.
Water obtained from: Schuylkill river.
Total area of water-shed available: 80 square miles.
Capacity of reservoir: 2,250,000 gallons.
Character and dimensions of dams: Receive water from Black Rock dam; 2 miles long, ¼ mile wide.
Cost of dam: $201,000.
Water first introduced: In 1873.
Description of main conduit: 1 mile long, 16 inches diameter; cast iron; 60 to 72 pounds pressure.
Description of distributing reservoir: 190 feet above level of river; lined inside, 18 inches clay; covered with brick and cement; division-wall, 6 feet high; depth of water, 11 feet.
Sizes of distributing mains: 16, 12, 10, 8, 6, and 4 inches.
Available head: 65 pounds (average).
Total length of distributing mains: About 12 miles.
Number of water-takers: 453.
Consumption of water: 450,000 gallons per day, or 64 gallons per head (exact).
First cost of water-works: $195,000.
Average annual cost of maintenance and repairs: $3,000; $14,000 bonded debt.
Number of fire-plugs: 126.
Design and dimensions of pump and water-plungers: Compound duplex, made by Worthington, New York; two plain plungers, 12 and 14 inches diameter, 24 inches stroke each, 24 strokes per minute; one 12- and one 14-inch pump-barrel.
Time pump is run: 10 hours per day (average).
Time spent in repairs: 10 days in a year (average).
Description of force-main: 900 feet long.
Description of water-valves: Rubber; 6 inches diameter, ¾ inch lift.
Kind of power used: Steam.
Description of boilers: Tubular, 5 by 14 feet; fuel, pea coal.

PHŒNIXVILLE—Continued.
Description of engine: Compound duplex condensing; high-pressure cylinder 23 inches diameter, low-pressure cylinder 36 inches diameter, 24 inches stroke, 15 strokes per minute; common globe-valves; double 15-inch bore air-pump, 12 inches stroke.
Duty of engine: 37,000,000 foot-pounds.
Remarks: The American Wood Paper Company's works are 2¼ miles above water-works on river, and refuse and chemicals used in dyeing contaminate the water.

PITTSTON:
Population: 7,472 inhabitants.
Name of corporation: Pittston Water Company (private).
Water obtained from: Susquehanna river.
Water first introduced: In 1856.
Description of distributing reservoir: Area, top, 129½ feet long, 106½ feet wide; bottom, 69½ feet long, 46½ feet wide; depth of water, 15 feet; capacity, 1,000,000 gallons.
Sizes of distributing mains: 12, 8, 6, 4, 3, and 2 inches.
Available head: 40 to 50 pounds.
Number of water-takers: 1,660.
Consumption of water: 50,000 gallons per day, or 70 gallons per head per day (estimated).
Average annual cost of maintenance and repairs: $7,839.
Number of fire-plugs: 38.
Design and dimensions of pump and water-plungers: Made by H. R. Worthington, New York, in 1877; 4 plungers, 16 inches diameter, 20½ inches stroke, 15 strokes per minute; pump-barrel, 20 by 24 inches.
Time pump is run: 10 hours per day (average).
Time spent in repairs: About 36 hours per year.
Description of force-main: 85 pounds pressure on pump.
Description of water-valves: Rubber; 6 inches diameter.
Kind of power used: Steam.
Description of boilers: Six plain cylinder; 36 feet long, 30 inches diameter; 75 pounds pressure; fuel used, culm.
Description of engine: Compound condensing; high-pressure cylinder 21½ inches diameter, low-pressure cylinder 34½ inches diameter, 20½ inches stroke, 15 strokes per minute; Worthington, duplex valves.
Cost of engine and pump: $7,500.
Duty of engine: 750,000 gallons daily; 2,000,000 gallons per day guaranteed.

SAINT PETERSBURG:
Population: 1,044 inhabitants.
Name of corporation: Saint Petersburg Water-Works (municipal).
Water obtained from: Spring.
Water first introduced: April, 1873.
Description of distributing reservoirs: Two wooden tanks; capacity, 39,600 gallons each.
Sizes of distributing mains: 4, 3, and 2 inches.
Available head: About 40 pounds (average).
Total length of distributing mains: 2 miles.
Number of water-takers: 125.
Consumption of water: 15,750 gallons per day (estimated).
First cost of water-works: $10,000.
Average annual cost of maintenance and repairs: $1,000.
Number of fire-plugs: 10.
Design and dimensions of pump and water-plunger: One Cameron pump, plain plunger; diameter of pump-barrel, 4 inches.
Time pump is run: 8 to 10 hours per day.
Description of force-main: 700 feet long, 2.2 inches diameter.
Kind of power used: Steam.
Description of boiler: One 15 horse-power (Tift); 40 pounds pressure; fuel, bituminous coal.
Cost of engine: $400.

SUMMIT HILL:
Population: 788 inhabitants.
Name of corporation: Summit Hill Water Company (private).
Water obtained from: Mountain streams.

SUMMITT HILL—Continued.
Total area of water-shed available: 2 square miles.
Capacity of reservoir: 24,000 cubic feet.
Cost of dam: $2,400.
Water first introduced: January, 1877.
Discharging capacity: 40 to 75 feet head.
Description of distributing reservoir: 100 feet long, 30 feet wide, 8 feet overflow.
Sizes of distributing mains: 8, 6, 4, and 3 inches.
Available head: 40 to 75 feet.
Total length of distributing mains: 7,000 feet.
Number of water-takers: 350.
Consumption of water: 15,000 gallons per day (estimated).
First cost of water-works: $12,000.
Average annual cost of maintenance and repairs: $720.
Number of fire-plugs: 13.
Design and dimensions of pump and water-plungers: Made by Carter & Allen, Tamaqua, Pennsylvania, in 1876; two plain plungers, 4 inches diameter, 18 inches stroke, 25 strokes per minute; pump-barrel, 4 inches diameter.
Time pump is run: About 5 hours per day.
Description of force-main: 5,700 feet long, 12 inches diameter; 130 pounds pressure on pumps.
Description of water-valves: Steam-valves.
Kind of power used: Steam.
Description of boilers: Upright tubular, 9 feet high, 48 inches diameter, 45 pounds pressure; fuel, anthracite coal.
Description of engine: Non-condensing, double; 12 inches diameter, 18 inches stroke, 25 strokes per minute; ordinary cut-off valves.
Cost of engine and pump: $2,300.
Duty of engine: 2,304,000 foot-pounds daily.

WESTCHESTER:
Population: 7,046 inhabitants.
Style of corporation: Municipal.
Water obtained from: Small creek.
Area and capacity of reservoir: 22,500 square feet; nearly 2,000,000 gallons.
Character and dimensions of dam: Very small one; pool, 200 by 100 feet, used for collecting and holding water; depth, 6 feet (average).
Cost of dam: Reservoir (proposed), $12,000.
Water first introduced: In 1840.
Description of main conduit: 1¼ mile long, 12 inches diameter; iron; head, 40 feet.
Description of distributing reservoir: 160 by 140 feet; has a division about 6 feet from bottom, making two sections; side sloped 30°; embankments rise 7 feet above ground, bottom 7 feet below ground; lined with clay and paved with brick.
Sizes of distributing mains: 8, 6, and 4 inches.
Available head: 40 to 100 feet.
Total length of distributing mains: 9 to 10 miles.
Number of water-takers: About 1,400.
Consumption of water: 250,000 gallons per day.
Average annual cost of maintenance and repairs: About $4,000.
Number of fire-plugs: 130.
Design and dimensions of pump and water-plunger: Pump-barrel, 7 inches diameter.
Time pump is run: 10 to 16 hours per day.
Kind of power used: Steam.

YORK:
Population: 13,940 inhabitants.
Style of corporation: Private.
Description of distributing reservoir: 200 by 300 feet, 11 feet deep.
Sizes of distributing mains: 10 to 2 inches.
Available head: 11 to 60 feet; water-supply deficient.
Total length of distributing mains: 13 miles.
Number of water-takers: 2,800.
Consumption of water: 273,600 gallons per day (estimated).

YORK—Continued.
Filtering apparatus: Cleaned every 5 years.
Design and dimensions of pump and water-plunger: Made by Berkenbine, Philadelphia, Pennsylvania, in 1850; round brass-ring plunger, 10 inches diameter, 36 inches stroke, 19 strokes per minute; pump-barrel, 10 inches diameter, 36 inches stroke.
Time pump is run: Constantly.
Description of force-main: 3,300 feet long, 90 feet rise, 10 inches diameter.
Description of water-valves: 8½ to 10½ inches.
Kind of power used: Steam.
Description of boilers: Return tubular; 60 pounds pressure; evaporated 3,000 gallons in 12 hours; fuel, anthracite coal.
Description of engine: Condenser, 10 inches diameter, 3 feet stroke, 56 strokes per minute; common valves.
Cost of engine and pump: $2,500.

TENNESSEE.

CHATTANOOGA:
Population: 12,892 inhabitants.
Name of corporation: Lookout Water Company (private).
Water obtained from: Tennessee river.
Cost of dams: $16,000.
Water first introduced: In 1869.
Description of main conduit: 12 inches diameter; iron.
Description of distributing reservoir: In two divisions; can discharge into either from pump, or supply city with either.
Sizes of distributing mains: 12 to 1½ inches.
Available head: 125 feet (average).
Total length of distributing mains: About 12 miles.
Number of water-takers: About 700.
Consumption of water: 1,250,000 gallons per day (estimated).
First cost of water-works: $115,000.
Average annual cost of maintenance and repairs: $16,050.
Number of fire-plugs: 58.
Design and dimensions of pump and water-plungers: Made by G. M. Woodward, New York, in 1869; plain double-acting plungers; two, 20 by 8 inches; two, 16 by 8 inches; one, 16 by 8 inches; 30 strokes per minute; pump-barrels, 12 and 9 inches diameter.
Time pumps is run: 20 hours per day.
Description of force-main: 800 feet long; 158 feet head on pump.
Description of water-valves: Metal.
Kind of power used: Steam.
Description of boilers: 22 feet long, 44 inches diameter; 4 flues, two 12 inches and two 29 inches diameter; 50 pounds pressure; fuel, soft coal.
Description of engines: Simple, high pressure; 16 and 20 inches diameter, 8 inches stroke, 30 and 50 strokes per minute; slide and eccentric valves.
Cost of engines and pump: $6,000.
Duty of engine: 3,628,125 foot-pounds daily.

TEXAS.

AUSTIN:
Population: 11,013 inhabitants.
Name of corporation: City Water Company (private).
Water obtained from: Colorado river.
Cost of dam: $10,000.
Water first introduced: February, 1876.
Description of distributing reservoir: 14,240 feet from pumps; covers 1 acre; capacity, 2,500,000 gallons; slopes are lined with concrete, 6 inches thick; elevation, 170 feet above pumps.
Sizes of distributing mains: 10, 8, and 6 inches.
Available head: 60 pounds (average).
Total length of distributing mains: About 10 miles.
Number of water-takers: 525.
Consumption of water: 227,309 gallons per day (exact).

AUSTIN—Continued.

First cost of water-works: $80,000.
Average annual cost of maintenance and repairs: $13,000.
Number of fire-plugs: 75.
Design and dimensions of pumps and water-plungers: Two, made by Blake & Co., Boston, Massachusetts, in 1875; bucket-plungers, 65 strokes per minute; pump-cylinder, 14 by 24 inches.
Time pumps are run: 2,207 hours per year.
Description of force-main: 14,240 feet long; 80 pounds pressure on pumps.
Description of water-valves: Rubber; 5 inches diameter.
Kind of power used: Steam.
Description of boilers: Two; flue; 14 feet long, 48 inches diameter, 55 pounds pressure.
Description of engine: Cylinder, 20 inches diameter, 24 inches stroke, 65 strokes per minute; Ludlow valves.
Duty of engines: 2,437,500 foot-pounds daily.

VERMONT.

BURLINGTON:

Population: 11,365 inhabitants.
Name of corporation: Burlington Water-Works (municipal).
Water obtained from: Lake Champlain.
Water first introduced: In 1866.
Discharging capacity: Head, 284 feet (average).
Description of distributing reservoir: Embankment; capacity, 3,000,000 to 4,000,000 gallons.
Sizes of distributing mains: 10, 6, 4, and 3 inches.
Total length of distributing mains: 25 miles.
Number of water-takers: 2,200.
Consumption of water: 600,000 gallons per day.
First cost of water-works: $450,000.
Average annual cost of maintenance and repairs: $6,443.
Number of fire-plugs: 138.
Design and dimensions of pumps and water-plungers: Two; made by H. R. Worthington, New York, in 1866; plain plungers, 10 inches diameter, 17 inches stroke, 21½ strokes per minute.
Time pumps are run: 10 hours per day.
Description of force-main: 1¼ mile long, 10 inches diameter.
Description of water-valves: 9 inlet and 9 discharge each cylinder; 3 inches diameter, ¼ inch lift.
Kind of power used: Steam.

BURLINGTON—Continued.

Description of boilers: Two multitubular, 14 feet long, 3½ feet diameter; 44 tubes, 3 inches diameter each; 40 pounds pressure; fuel, anthracite coal.
Description of engine: Compound; high-pressure cylinder 14 inches diameter, low-pressure cylinder 24½ inches diameter, 17 inches stroke, 21½ strokes per minute each; slide-valves; condenser, 14 by 48 inches; air-pump, 9 by 17 inches.
Cost of pumps and engine: $10,600.
Remarks: Whole pumping plants in bad condition.

VIRGINIA.

DANVILLE:

Population: 7,526 inhabitants.
Name of corporation: Danville Water and Gas Works (municipal).
Water obtained from: Dan river.
Capacity of reservoir: 1,500,000 gallons.
Water first introduced: In 1875.
Description of distributing reservoir: 165 by 155 feet top, 15 feet deep; slope 2 to 1; made of loose earth, embankments lined with brick.
Sizes of distributing mains: 10, 8, 6, 4, and 3 inches.
Available head: 19 to 180 feet.
Total length of distributing mains: 8.2 miles.
Number of water-takers: 306.
First cost of water-works: $141,500.
Average annual cost of maintenance and repairs: $6,475 68 in 1880.
Number of fire-plugs: 66.
Design and dimensions of pump and water-plungers: Made by H. R. Worthington, New York, in 1875; two plain plungers, 18 inches diameter, 12 inches stroke, 100 to 200 strokes per minute.
Description of force-main: 3,600 feet long; 80 pounds pressure on pump.
Description of water-valves: Gum; 2 inches diameter.
Kind of power used: Steam.
Description of boilers: Tubular; 15 feet long, 5 feet diameter; 52 flues; 65 pounds pressure; fuel, wood.
Description of engine: Non-condensing; 20 inches diameter, 12 inches stroke, 100 to 180 strokes per minute.
Duty of engine: 1,000,000 foot-pounds daily.

WATER-WORKS EMPLOYING SYSTEM OF PUMPING TO STAND-PIPE.

ARKANSAS.

LITTLE ROCK:

Population: 13,138 inhabitants.
Name of corporation: Little Rock Water Company (private).
Water obtained from: Arkansas river; about to use well in soil, near river, ½ mile above court-house; rest, drive-wells.
Water first introduced: In 1878.
Description of stand-pipe: 100 feet high, 20 feet diameter; wrought iron; one outlet and one inlet; used as surplus over direct pumping; filled at night.
Sizes of distributing mains: 12, 10, 8, 6, and 4 inches.
Total length of distributing mains: 5 miles.
Number of water-takers: 300.
Consumption of water: About 200,000 gallons per day.
First cost of water-works: Contract was for $100,000.
Average annual cost of maintenance and repairs: $3,000.
Number of fire-plugs: 100.
Design and dimensions of pumps and water-plungers: Two, double-acting, made by George F. Blake, New York, in 1878; piston-plunger, 14 inches diameter, 24 inches stroke; varies up to 45 double strokes per minute; pressure on pumps, about 62 pounds.
Time pumps are run: One or the other 8 to 10 hours per day.
Description of force-main: About 300 feet long, 12 inches diameter.
Description of water-valves: Brass disks; 24 inlet and 24 discharge; 3 inches diameter; maximum lift, ¾ inch.
Kind of power used: Steam.
Description of boilers: Two, cylindrical; 20 feet long, 48 inches diameter; 12 tubes, 5½ inches diameter, in each; 80 to 130 pounds pressure.
Fuel: Pittsburgh coal.
Description of engine: High-pressure condensing; cylinder, 30 inches diameter, 24 inches stroke, up to 45 double strokes per minute; slide-valves by piston-valve rod; Berkeley condenser.
Duty of engine: 1,000,000 gallons daily.

GEORGIA.

AUGUSTA:

Population: 21,891 inhabitants.
Name of corporation: Augusta Water-Works (municipal).
Water obtained from: Savannah river by Augusta canal.
Character and dimensions of dam: 1,700 feet long, 9 feet deep (average), 6 feet wide, top; upstream fall 15 inches lower than downstream; rubble masonry.
Cost of dam: $30,000.
Water first introduced: In 1861.
Description of main conduit: 345.5 feet long, 20 inches diameter; cast iron.
Discharging capacity: 9.33 cubic feet per second; head, 17 feet (average).
Description of stand-pipe: Two concentric brick towers 68 feet high, supporting a boiler-iron tank 37 feet diameter and 30 feet deep.
Sizes of distributing mains: 6 and 4 inches.
Available head: 25 to 32 pounds; water-supply deficient.
Total length of distributing mains: 21.61 miles.

AUGUSTA—Continued.

Number of water-takers: 1,644.
Consumption of water: 81.5 gallons per head per day (estimated).
Average annual cost of maintenance and repairs: $7,342 78.
Filtering apparatus: Three settling basins; bricks set on edge; capacity, 18,000,000 gallons.
Number of fire-plugs: 163.
Design and dimensions of pump and water-plungers: Made by I. P. Morris & Co., Philadelphia, Pennsylvania, in 1860; two bucket-plungers, 18¼ inches diameter, 3 feet stroke, 20 strokes per minute; pump-barrel, 3 feet by 18¼ inches.
Time pump is run: Constantly.
Time spent in repairs: 24 hours per year.
Description of force-main: 2,490 feet long, 16 inches diameter, 38.12 pounds pressure; 88 feet head on pump.
Kind of power used: Water and steam.
Description of water-wheel: Jonval turbine, 45 horse-power, 11 feet head, 66 revolutions per minute.
Description of boiler: 15 feet long, 4 feet diameter; 63 flues, 3 inches diameter.
Description of engines: Steam, simple, 20 inches diameter, 24 inches stroke; water, 14 inches diameter, 24 inches stroke, 65 strokes per minute.

SAVANNAH:

Population: 30,709 inhabitants.
Name of corporation: Savannah Water-Works (municipal).
Water obtained from: Savannah river.
Water first introduced: In 1854.
Description of stand-pipe: Brick tower, 50 feet high, 12-inch iron beams on top support a tank of boiler-iron 30 feet diameter and 57 feet high.
Sizes of distributing mains: 12, 6, and 4 inches.
Available head: About 40 pounds (average); water-supply deficient, because mains are too small.
Total length of distributing mains: 22 miles.
Number of water-takers; 2,013.
Consumption of water: 75 gallons per head per day.
First cost of water-works: $225,000.
Average annual cost of maintenance and repairs: $11,000.
Number of fire-plugs: 257.
Design and dimensions of pumps and water-plungers: Made by Worthington, one in 1854, and one duplex in 1874; plain plungers, 17¾ inches diameter, 3 feet stroke, about 40 strokes per minute.
Time pumps are run: Constantly.
Description of force-mains: Two, each 3,000 feet long, 16 and 12 inches diameter; 56 pounds pressure on pumps.
Description of water-valves: India-rubber; 7 inches diameter, ⅛ inch lift.
Kind of power used: Steam.
Description of boilers: Return tubular; 14 feet long, 48 inches diameter; 40 pounds pressure; fuel, wood.
Description of engine: Compound condensing; high-pressure cylinder, 21 inches diameter, 3 feet stroke; expansion cylinder, 36 inches diameter, 3 feet stroke, 40 strokes per minute; common D valve.
Cost of pumps and engine: $25,000.
Duty of engine: 45,000,000 foot-pounds daily.
Remarks: Water discolored during freshet by red clay.

INDIANA.

SOUTH BEND:

Population: 13,280 inhabitants.
Style of corporation: Municipal.
Water obtained from: Saint Joseph river.
Character and dimensions of dam: 600 feet long, 9 feet fall; made of wood
Cost of dam: $100,000.
Water first introduced: In 1873.
Description of stand-pipe: 204 feet high, 5 feet diameter.
Sizes of distributing mains: 20, 16, 12, 10, 8, and 6 inches.
Available head: 150 feet.
Total length of distributing mains: 16 miles.
Number of water-takers: 500.
First cost of water-works: $170,000.
Average annual cost of maintenance and repairs: About $3,000.
Number of fire-plugs: 200.
Design and dimensions of pump and water-plungers: Made by Flanders & Co., Vergennes, Vermont; plain plungers, 14 by 20 inches, 6 double-acting, taking and discharging water at each end of cylinder; 20 strokes per minute; pump-barrel, 14 inches diameter.
Time pump is run: Constantly.
Time spent in repairs: 48 hours per year.
Description of force-main: 300 feet long, 150 feet head on pump.
Description of water-valves: Iron, with rubber and brass; rubber removable, and brass on seats; 10 inches diameter, 1 foot lift.
Kind of power used: Water.
Description of water-wheels: Three 66-inch American turbines, made by Stout, Mills, & Temple, Dayton, Ohio; 7 to 9 feet head; 16 revolutions per minute.
Cost of engine and pump: $4,000.

TERRE HAUTE:

Population: 26,042 inhabitants.
Name of corporation: Terre Haute Water-Works Company (private).
Water obtained from: Wabash river.
Description of stand-pipe: Each pump has a close stand-pipe 28 feet high, 24 inches diameter, into which all the water is pumped; from thence, by compressed air, it is forced into the mains.
Sizes of distributing mains: 16, 12, 10, 8, 6, and 4 inches.
Available head: 40 pounds (average).
Total length of distributing mains: 17$\frac{201}{320}$ miles.
Number of water-takers: 453.
Consumption of water: 900,000 gallons per day (estimated).
First cost of water-works: $300,951.
Average annual cost of maintenance and repairs: $6,500.
Filtering apparatus: Coarse gravel in gallery; cleaned twice per year.
Number of fire-plugs: 374.
Design and dimensions of pump and water-plungers: Made by Clapp & Jones, Hudson, New York, in 1873; 4 grooved plungers, 9 inches diameter, 36 inches stroke, 6 to 60 strokes per minute; pump-barrel, 9 by 36 inches.
Time pump is run: Constantly.
Description of force-main: 16 inches diameter; 40 pounds pressure on pump.
Description of water-valves: Clapp's, patent rubber; 1 inch thick, 4 inches wide.
Kind of power used: Steam.
Description of boilers: Two; 16 feet long, 44 inches diameter; two 16-inch flues each; 1 Babcock & Wilcox, 75 horse-power; fuel, slack coal.
Description of engines: Four condensing beam, 20 inches diameter, 36 inches stroke, 6 to 60 double strokes per minute; common slide cut-off; air-pump, 10 by 15 inches; jet-condenser.
Cost of engines and pump: $45,000.
Duty of engines: 45,000,000 foot-pounds daily (average).

MASSACHUSETTS.

FALL RIVER:

Population: 48,961 inhabitants.
Name of corporation: Fall River Water-Works (municipal).
Water obtained from: Watuppa lakes.
Total area of water-shed available: 31$\frac{1}{4}$ square miles.
Water first introduced: In 1874.
Description of main conduit: 87 feet long; cross-section, 6 feet wide; to crown of each inside radius, 3 feet; brick.
Description of stand-pipes: One 80 feet high, the other 40 feet high; each 3 feet 6 inches diameter; built of boiler-iron.
Sizes of distributing mains: 24 to 6 inches.
Total length of distributing mains: 52.05 miles.
Number of water-takers: 2,809.
Consumption of water: 27 gallons per head per day (estimated).
First cost of water-works: $1,451,364 52.
Average annual cost of maintenance and repairs: $20,000.
Number of fire-plugs: 537.
Design and dimensions of pumps and water-plungers: One, made by Boston Machine Company, in 1874, two plungers, 16 inches diameter, 48 inches stroke; one, duplex Worthington, 1875, plain plunger, 22$\frac{1}{4}$ inches diameter, 48 inches stroke; one, 22 inches diameter, 48 inches stroke, 4 strokes per minute.
Time pumps are run: Constantly.
Time spent in repairs: 19 days in 1880.
Description of force-main: 1,350 feet long; head on low-pressure 151 feet, high-pressure 186 feet (average).
Description of water-valves: Rubber; 6 inches diameter, $\frac{1}{4}$ inch lift.
Kind of power used: Steam.
Description of boilers: Two, return tubular, 6 feet 6 inches by 6 feet long, with 96 tubes, 4 inches diameter each; fuel, Cumberland coal.
Description of engines: Boston, condensing; puppet-valves operated by cams; air-pump, 27 by 29$\frac{1}{2}$ inches, 23 inches stroke; 6 feet 6 inches rubber-top valve; condenser, 6 by 3 feet. Worthington compound, 11.6 strokes per minute; balance slide-valves.
Cost of engines and pumps: Boston, $36,760 18; Worthington, $50,371 21.
Duty of engines: Boston, 23,414,336 foot-pounds daily; 60,000,000 foot-pounds guaranteed. Worthington, 49,914,028 foot-pounds daily; 65,000,000 foot-pounds guaranteed.

NANTUCKET:

Population: 3,727 inhabitants.
Name of corporation: Wannacomet Water Company (private).
Water obtained from: Wannacomet lake.
Total area of water-shed available: 25 acres.
Capacity of reservoir: 50,000 gallons.
Cost of dam: $2,500.
Water first introduced: In 1879.
Description of main conduit: 2 miles long, 8 inches diameter; cast iron; 104 feet head (average).
Description of stand-pipe: $\frac{1}{4}$-inch boiler-iron circular tank, 24 feet diameter, 15 feet deep, 42 feet above ground, on iron trestle-work.
Sizes of distributing mains: 6, 4, and 2 inches.
Available head: About 90 feet (average).
Total length of distributing mains: About 5 miles.
Number of water-takers: 150.
Consumption of water: 60,000 gallons per day (estimated).
First cost of water-works: $40,000.
Average annual cost of maintenance and repairs: About $600.
Number of fire-plugs: 4.
Design and dimensions of pumps and water-plungers: One made by H. R. Worthington, New York, in 1880; two plain plungers, 14 inches diameter, 10 inches stroke; one made by G. F. Blake & Co., Boston, in 1878; two plain plungers, 6 inches diameter, 12 inches stroke, 200 strokes per minute.
Time pumps are run: One pump 5 hours per day.
Description of force-main: 400 feet long, 8 inches diameter; 38 pounds pressure on pumps.

NANTUCKET—Continued.
Description of water-valves: Rubber disks.
Kind of power used: Steam.
Description of boilers: One upright tubular, 15 horse-power; 77 tubes, 2 inches diameter, 5 feet long; 60 pounds pressure; one locomotive, 45 horse-power; 83 tubes, 2 inches diameter, 12 feet long; 60 pounds pressure; fuel, hard coal.
Cost of pump and engine: $1,800.

NEW JERSEY.

BELVIDERE:
Population: 1,773 inhabitants.
Name of corporation: Belvidere Water-Works (private).
Water obtained from: Delaware river.
Water first introduced: In 1878.
Description of main conduit: 235 feet long, 10 inches diameter; cast iron; head, 160 feet (average).
Description of stand-pipe: 160 feet high; made of heavy boiler-iron, on stone foundation.
Sizes of distributing mains: 8, 6, and 4 inches.
Available head: About 100 feet (average).
Total length of distributing mains: About 15,000 feet.
Number of water-takers: 106.
Consumption of water: 35,000 gallons per day (estimated).
First cost of water-works: About $40,000.
Number of fire-plugs: 15.
Design and dimensions of pump and water-plungers: Blake's duplex pump, made by Blake Manufacturing Company, Boston and New York, in 1878; two plungers, bucket or suction, 8 inches diameter, 12 inches stroke, 100 strokes per minute (average); pump-barrel, 8 inches diameter.
Time pump is run: About 2 hours per day.
Description of force-main: 164 feet long; 80 pounds pressure on pumps.
Description of water-valves: Rubber; 3 inches diameter, inch lift.
Kind of power used: Steam.
Description of boilers: Tubular; 50 pounds pressure (aver age); fuel, No. 2 chestnut coal.
Description of engine: Simple; 14 inches diameter, 12 inches stroke, 100 strokes per minute (average); Blake's patent valves.
Cost of engine and pumps: About $2,700.
Remarks: Water very pure.

MILLVILLE:
Population: 7,660 inhabitants.
Name of corporation: Millville Water Company (private).
Water obtained from: Well.
Water first introduced: In 1879.
Description of stand-pipe: 128 feet high, 12 feet diameter.
Sizes of distributing mains: 12, 8, 6, 4, and 3 inches.
Available head: 40 pounds (average).
Total length of distributing mains: 41,364 feet.
Number of water-takers: 227.
Consumption of water: 150,000 gallons per day (estimated).
First cost of water-works: $63,620 85.
Average annual cost of maintenance and repairs: $1,500.
Number of fire-plugs: 67.
Design and dimensions of pump and water-plunger: Made by R. D. Wood & Co., Philadelphia, Pennsylvania; plain double-plunger, 10 by 40 inches, 16 strokes per minute; pump-barrel 10 by 40 inches.
Time pump is run: 6 hours per day.
Description of force-main: 12 inches diameter; 40 pounds pressure on pump.
Description of water-valves: Rubber, 5¼ inches diameter, 1¼ inch lift.
Kind of power used: Water.
Description of water-wheel: Turbine, 36 inches diameter, made by R. D. Wood & Co.; 21 feet head, 115 revolutions per minute.
Cost of engine and pump: $6,000.
Remarks: Water slightly colored by vegetable matter in cedar-swamps.

OHIO.

LANCASTER:
Population: 6,803 inhabitants.
Name of corporation: Lancaster Water-Works (municipal)
Water obtained from: Hocking canal.
Water first introduced: In 1877.
Description of stand-pipe: 70 feet high.
Size of distributing mains: 6 inches.
Available head: 55 pounds (average).
Number of water-takers: 30.
First cost of water-works: $15,000.
Number of fire-plugs: 26.
Design of pump and water-plunger: Made by Smith, Vail, & Co., Dayton, Ohio.
Time pump is run: 1 hour per day.
Description of force-main: Head, 130 feet; 55 pounds pressure on pumps.
Kind of power used: Steam.
Description of boiler: Upright, 20 horse-power, 70 pounds pressure; fuel, soft coal.
Cost of engine and pump: $1,000.
Remarks: Canal water is unfit for use, but new works are in preparation and will be built in 1881.

PENNSYLVANIA.

BRISTOL:
Population: 5,273 inhabitants.
Name of corporation: The Bristol Water Company (private).
Water obtained from: Delaware river.
Water first introduced: February, 1875.
Description of stand-pipe: 140 feet high above stone foundation, 6 feet diameter.
Sizes of distributing mains: 12, 10, 8, and 4 inches.
Available head: 45 pounds (average).
Total length of distributing mains: 3½ miles.
Number of water-takers: 256.
Consumption of water: Average pumping, 140,000 gallons; 110,000 gallons are estimated to go to railroad company.
First cost of water-works: $39,450.
Average annual cost of maintenance and repairs: About $40.
Design and dimensions of pumps and water-plungers: Two direct-acting duplex, made by Worthington, New York, in 1875; 4 plain plungers, 10¾ inches diameter, 10 inches stroke, 23 strokes per minute (average).
Time pumps are run: About 10 hours per day.
Description of force-main: 20 feet long, 8 inches diameter, 45 pounds pressure on pumps.
Description of water-valves: Rubber, 3 inches diameter, ¼ inch lift.
Kind of power used: Steam.
Description of boilers; Return tubular, 9 feet long, 44 inches diameter, 40 pounds pressure; fuel, pea coal.
Description of engine: Non-condensing, 16 by 10 inches, 132 strokes per minute; slide-valve operated by opposite piston.
Cost of engine and pumps: $5,500.
Duty of engine: 1,500,000 foot-pounds daily.

SOUTH CAROLINA.

CHARLESTON:
Population: 49,984 inhabitants.
Name of corporation: City Water-Works (private).
Water obtained from: Artesian well, 1,964 feet deep.
Area and capacity of reservoir: 3,300,000 gallons.
Water first introduced: In 1880.
Description of main conduit: ¼ mile long, 4 feet diameter; cast iron.
Description of stand-pipe: 76 feet high, 18 feet diameter, 90 feet above pump.
Sizes of distributing mains: 16, 12, 10, 8, and 6 inches.
Available head: 60 to 90 feet; water-supply deficient during very dry weather for a few hours daily.
Total length of distributing mains: 16 miles.
Number of water-takers: 500.

CHARLESTON—Continued.

Consumption of water: 210,000 gallons per day.
First cost of water-works: $400,000.
Average annual cost of maintenance and repairs: $7,000.
Number of fire-plugs: 208.
Design and dimensions of pump and water-plungers: Made by Knowles Manufacturing Company, New York, in 1880; plain plungers, 20 strokes per minute; pump-barrel, 20 by 36 inches.
Time pump is run: 3 to 4 hours per day.
Description of force-main: 80 feet long, 20 inches diameter; head, 90 feet; 38.98 pounds pressure on pump.
Description of water-valves: India-rubber, ⅜ to 1 inch.
Kind of power used: Steam.
Description of boilers: 60 pounds pressure; fuel, anthracite coal.
Description of engine: Compound; high-pressure cylinder 20 inches diameter, 36 inch stroke; low-pressure cylinder, 38 inches diameter, 36 inches stroke; 32 to 44 strokes per minute; Knowles' valves and condenser.
Cost of engine and pump: $32,000.

TEXAS.

DALLAS:

Population: 10,358 inhabitants.
Name of corporation: Dallas Water-Supply Company (private).
Water obtained from: Wells, springs, and Trinity river.
Available head: 40 to 80 feet.
Consumption of water: 114,000 gallons daily.
Filtering apparatus: Gallery; gravel, not yet tested.
Design and dimensions of pump and water-plungers: Made by G. F. Blake Manufacturing Company, Chicago and Boston; one Blake plunger 24 inches; 103 steam-cylinder, 140 water-cylinder; one Knowles plunger, 10 inches, horizontal, 24-inch valve; 21-inch steam-cylinder; pump-barrels, 6 and 10 inches diameter.
Time pump is run: 16 hours per day.
Description of water-valves: Rubber, 50 inches diameter, 3 inches lift.
Kind of power used: Steam.
Description of engine: Simple, non-condensing.

731

WATER-WORKS EMPLOYING SYSTEM OF PUMPING DIRECT INTO DISTRIBUTING MAINS.

CALIFORNIA.

CHICO:

Population: 3,300 inhabitants.
Name of corporation: Chico Water Company (private).
Water obtained from: Well.
Water first introduced: In 1875.
Sizes of distributing mains: 8, 6, 4, and 3 inches.
Available head: 50 feet (average).
Total length of distributing mains: 5 miles.
Number of water-takers: 210.
Consumption of water: 300,000 gallons per day (estimated).
First cost of water-works: $50,000.
Average annual cost of maintenance and repairs: $4,200.
Number of fire-plugs: 30.
Design and dimensions of pump: Hooker pump, made by Garrett & Co., San Francisco, in 1875–'78; plain plunger, with metallic packing, 150 strokes per minute; pump-barrels, 2 and 8 inches diameter.
Time pump is run: 10 hours per day.
Time spent in repairs: 150 hours per year.
Description of force-main: 3,000 feet long, 8 inches diameter; 22½ to 26 pounds pressure on pump.
Description of water-valves: Rubber, 6 inches diameter, 1¼ inch lift.
Kind of power used: Steam.
Description of boilers: Two, 16 feet long, 42 inches diameter, 40 to 60 pounds pressure; fuel, wood.
Description of engines: 10 inches diameter, 16 inches stroke; 20 inches diameter, 24 inches stroke.
Cost of engines and pumps: $4,500.

SACRAMENTO:

Population: 21,420 inhabitants.
Name of corporation: Sacramento City Water-Works (municipal).
Water obtained from: Sacramento river.
Total area of water-shed available: 18,000 square miles.
Water first introduced: April, 1854.
Sizes of distributing mains: 20 to 3 inches.
Available head: 40 pounds (average).
Total length of distributing mains: About 25 miles.
Number of water-takers: 3,900.
First cost of water-works: $300,000.
Average annual cost of maintenance and repairs: $25,000.
Number of fire-plugs: 277.
Design and dimensions of pumps: One set, made by Holly Manufacturing Company, Lockport, New York; piston type water-plunger, double-acting, 10 inches diameter, 27¼ inches stroke, 75 to 80 strokes per minute; one Stevens, built by Central Pacific Railroad Company, Sacramento, California; plunger, 80 inches stroke, 24 inches diameter, 28 to 30 strokes per minute; pump-barrels: Holly, 10 by 35 inches; Stevens, 24 by 96 inches; head on pumps, 92.16 feet.
Time pumps are run: Constantly.
Description of water-valves: Stevens, rubber, ⅞ inch thick, 7 by 14 inches; Holly, iron plates, shod with rubber, 5 by 11 inches, 1 inch lift.
Kind of power used: Steam.

SACRAMENTO—Continued.

Description of boilers: Three tubular, 16 feet long, 60 inches diameter; 58 tubes, 4 inches diameter; 75 pounds pressure; fuel, gas-coke.
Description of engines: Holly, non-condensing, condensing, and compound; 16 inches diameter, 27¼ inches stroke, 75 to 80 strokes per minute; plain valves, with puppet cut-off; Stevens, condensing, 36 inches diameter, 80 inches stroke, 28 to 30 strokes per minute; balanced slide-valves; 2 air-pumps, 16 by 20 inches and 20 by 24 inches; condensers for both.
Cost of pumps and engines: Holly, $58,000; Stevens, $30,000.
Duty of engines: 1,000,000 foot-pounds per bushel of coke daily.
Remarks: The advantages of direct pumping are that pressure can be controlled, but when pumps stop working, the supply is also stopped.

COLORADO.

DENVER:

Population: 35,629 inhabitants.
Name of corporation; City Water Company (private).
Water obtained from: South Platte river.
Character and dimensions of dam: Dam across river, 3 miles south of Denver.
Cost of dam: $100,000.
Water first introduced: In 1870.
Description of main conduit: Canal, 2¼ miles long, 28 feet fall.
Sizes of distributing mains: 20 to 3 inches.
Total length of distributing mains: 35 miles.
Number of water-takers: 2,500.
Consumption of water: 75 gallons per head per day (exact).
First cost of water-works: $600,000.
Average annual cost of maintenance and repairs: $25,000.
Filtering apparatus: Gallery, 30 by 10 feet; sides and ends, 8 feet through; filled with sand and gravel; cleaned once a year.
Number of fire-plugs: 300.
Design and dimensions of pumps and water-plungers: Made by Holly Manufacturing Company, Lockport, New York, 1874; six bucket-plungers, 16 inches diameter, 16 inches stroke, 30 strokes per minute.
Time pumps are run: Constantly.
Description of force-main: 50 pounds pressure on pumps; domestic, 135 pounds pressure on pumps.
Description of water-valves: Old works, clack; new works, rubber disks.
Kind of power used: Steam and water.
Description of water-wheels: Two American turbines, made by Stout, Mills, & Temple, Dayton, Ohio; 54 inches diameter, 30 feet head, 115 revolutions per minute.
Description of boilers: Tubular, 54 inches diameter, 18 feet long; 16 flues, 6 inches diameter each; 7 pounds of water to 1 pound of coal; fuel, slack coal.
Description of engines: Compound; two 16 inches diameter, 27 inches stroke; one, 18 inches diameter, 27 inches stroke; one 25 inches diameter, 30 inches stroke; 15 to 115 strokes per minute (double); old works, slide- and puppet-valves; new works, puppet, operated by French cams; jet-condenser.
Cost of engines and pumps: $100,000.

PUEBLO:

Population: 3,217 inhabitants.
Name of corporation: Pueblo City Water-Works (municipal).
Water obtained from: Arkansas river.
Water first introduced: November, 1874.
Sizes of distributing mains: 12, 8, 6, and 4 inches.
Total length of distributing mains: 6½ miles.
Number of water-takers: 350.
Consumption of water: 375,000 gallons per day (estimated).
First cost of water-works: $120,000.
Average annual cost of maintenance and repairs: $6,500.
Filtering apparatus: Well, 50 feet diameter; gravel; cleaned *once a year*; *settling reservoir* being constructed, 100 by 500 feet.
Number of fire-plugs: 66.
Design and dimensions of pump and water-plungers: Made by Holly Manufacturing Company, Lockport, New York, 1874; four double-acting piston-plungers, 6½ inches diameter, 21 inches stroke, 10 strokes per minute; pump-barrel, 6½ by 21 inches.
Time pump is run: Constantly.
Description of force-main: 6½ miles long; head, 100 feet on pump.
Description of water-valves: Rubber, 8 inches long, 2 inches diameter, ¾ inch lift.
Kind of power used: Steam.
Description of boilers: Two return-flue, 12 feet long, 56 inches diameter; 41 tubes, 4 inches diameter each, 7 pounds pressure; fuel, screenings from lignite coal.
Description of engine: Usually compound, four cylinders, 10 inches diameter, 21 inches stroke, 20 strokes per minute; slide, also a variable cut-off valve; two air-pumps, 10 inches diameter, 12 inches stroke; jet-condenser.
Cost of engine and pump: $28,000.
Duty of engine: *3,000,000 foot-pounds to 100 pounds coal daily.*
Remarks: The advantage of direct pumping into main is the control of pressure.

GEORGIA.

ATLANTA:

Population: 37,409 inhabitants.
Name of corporation: Atlanta Water-Works (municipal).
Water obtained from: Two small streams.
Capacity of reservoir: 258,000,000 gallons.
Character and dimensions of dam: 46 feet high, 300 feet wide at base, 12 feet wide at top; earth, with puddle wall in center.
Cost of dam: $46,997 46.
Water first introduced: In 1875.
Sizes of distributing mains: 12 to 4 inches.
Available head: 90 to 100 feet; water-supply deficient.
Total length of distributing mains: 14 miles.
Number of water-takers: 1,270.
Consumption of water: 2,250,000 gallons per day (average exact).
First cost of water-works: $350,000.
Average annual cost of maintenance and repairs: About $3,500.
Number of fire-plugs: 221.
Design and dimensions of pump and water-plunger: Made by Holly Manufacturing Company, Lockport, New York; plain plunger, 7¼ inches diameter, 27 inches stroke; strokes per minute vary; pump-barrel, 7¼ to 27 inches.
Time pump is run: Constantly.
Description of force-main: 3½ miles long, 16 inches diameter; 110 pounds pressure on pump.
Description of water-valves: Clack; 2 by 6 inches, ½ inch lift.
Kind of power used: Steam.
Description of boilers: Three tubular, 8 pounds pressure; *fuel, bituminous coal.*
Description of engine: Compound; 20 to 60 strokes per minute; slide-valves, with balance cut-off; jet-condenser.

ATLANTA—Continued.

Cost of engines and pumps: $50,000.
Duty of engine: About 55,000,000 foot-pounds daily.
Remarks: The advantage of pumping direct into distributing mains is (1) less first cost; (2) no greater cost to operate.

ILLINOIS.

DECATUR:

Population: 9,547 inhabitants.
Style of corporation: Municipal.
Water obtained from: Sangamon river.
Water first introduced: In 1871.
Description of main conduit: 300 feet long, 24 inches diameter; cast iron.
Discharging capacity: 17,000,000 gallons per 24 hours; 6 feet head (average).
Sizes of distributing mains: 12, 8, 6, 4, 2, and 1¼ inches.
Available head: 150 feet (average).
Total length of distributing mains: 50,554 feet.
Number of water-takers: 275.
First cost of water-works: $75,000.
Average annual cost of maintenance and repairs: About $5,000.
Filtering apparatus: Gallery, 500 feet long, 4 feet below bed of river; 10 feet wide; 6-foot wall, with brick arch; filled with gravel.
Number of fire-plugs: 90.
Design and dimensions of pumps and water-plungers: Made by Cameron, New York; plain plunger, 12 inches diameter, 3 feet stroke, 15 to 30 strokes per minute; pump-barrel, 12 inches diameter.
Time pumps are run: Constantly.
Description of force-main: 5,280 feet long, 12 inches diameter; 70 pounds pressure on pumps.
Description of water-valves: Plain; 12, 6, and 4 inches.
Kind of power used: Steam.
Description of boilers: One tubular, 14 feet long; one flue, 20 feet long; 5 flues; 70 pounds pressure.
Description of engine: Non-condensing, simple; 18 inches diameter, 3 feet stroke, 15 to 20 strokes per minute; globe-valves; common air-chamber.
Cost of engines and pumps: Two Cameron, $3,000.
Duty of engines: 432,000 gallons in 24 hours, each pump, daily; 864,000 gallons in 24 hours, each pump, guaranteed.
Remarks: The advantage of pumping direct to mains consists in great pressure in case of fire.

GENESEO:

Population: 3,518 inhabitants.
Style of corporation: Municipal.
Water obtained from: Well.
Area and capacity of reservoir: 25 by 65 feet, 13 feet deep; 120,000 gallons.
Cost of dam: $1,000.
Water first introduced: October, 1879.
Description of distributing chamber: 5 feet diameter, 12 feet high; air-tight; made of boiler-iron; pump discharges into this chamber, and mains are connected with it.
Sizes of distributing mains: 8, 6, and 4 inches.
Available head: 30 pounds (average).
Total length of distributing mains: About 1½ mile.
Number of water-takers: 60.
First cost of water-works: $14,500.
Average annual cost of maintenance and repairs: $1,025.
Number of fire-plugs: 14.
Design and dimensions of pump and water-plungers: Perkins, made by William Orten Manufacturing Company, Sterling, Illinois; 2 plain plungers, 12 by 8 inches diameter, 150 strokes per minute.
Time pump is run: Constantly.
Description of force-main: 30 pounds pressure on pump.
Description of water-valves: Area exceeds water-plungers; made of rubber, ⅞ inch lift.
Kind of power used: Steam.

GENESEO—Continued.

Description of boilers: Two horizontal tubular, 12 feet long, 42 inches diameter; fuel, soft coal.

Description of engine: Non-condensing, single or duplex; 14 by 12 inches, 8 to 150 or 200 strokes per minute; common slide-valves.

Cost of engine and pump: $1,700.

Duty of engine: 1,000,000 gallons in 24 hours (daily).

Remarks: The advantage of pumping direct to distributing mains is control of pressure.

HYDE PARK:

Population: 15,716 inhabitants.

Name of corporation: Hyde Park Water-Works (municipal).

Water obtained from: Lake Michigan.

Water first introduced: In September, 1874.

Description of main conduit: 1,700 feet long, 16 inches diameter.

Sizes of distributing mains: 16 to 4 inches.

Available head: 110 feet (average).

Total length of distributing mains: About 29 miles.

Number of water-takers: 1,350.

Consumption of water: 1,229,134,425 gallons per year (exact).

First cost of water-works: $400,000.

Annual cost of maintenance and repairs: $6,924 13 in 1880.

Number of fire-plugs: 147.

Design and dimensions of pumps and water-plungers: Made by Holly Manufacturing Company, Lockport, New York; 4 piston-pumps, 9¼ inches diameter, 24 inches stroke, 10 to 40 strokes per minute; pump-barrel, 9¼ by 32 inches; one, made by Knowles, New York, plain plunger, 20 inches diameter, 36 inches stroke, 15 to 25 strokes per minute; pump-barrel, 12 inches long.

Time pumps are run: Constantly.

Time spent in repairs: 250 hours per year.

Description of force-main: 1¼ mile long, 16 inches diameter.

Description of water-valves: Holly, leather-faced hinge, 9 by 4 inches, 1¼ inch lift; Knowles, rubber disks, 3¼ inches diameter, ⅞ inch lift.

Kind of power used: Steam.

Description of boilers: Tubular, 16 feet long, 5 feet diameter, 75 pounds pressure; 7 1⅞ pounds water to 1 pound coal; fuel, Indiana block bituminous coal.

Description of engines: Holly, non-condensing, condensing, or compound, at will; four cylinders, 14 by 24 inches, 10 to 40 strokes per minute; D-valve, puppet cut-off; two air-pumps, 14 inches diameter, 18 inches stroke; jet-condenser. Knowles, compound; high-pressure cylinder 20 inches diameter, low-pressure cylinder 38 inches diameter, 36 inches stroke, 15 to 25 strokes per minute; two air-pumps, 8 inches diameter, 18 inches stroke; D-valves worked by piston; jet-condenser.

Cost of engines and pumps: $40,000.

Duty of engines: 30,210,000 foot-pounds daily; Knowles, 60,000,000 foot-pounds guaranteed.

Remarks: The advantages of pumping direct into mains are cheapness of construction, and no fire-engines.—Water-works to point of distribution built and maintained in common with the town of Lake, Illinois.

LAKE:

Population: 18,380 inhabitants.

Style of corporation: Municipal.

Water obtained from: Lake Michigan.

Water first introduced: In 1874.

Description of main conduit: 16 inches in diameter.

Discharging capacity: 5,000,000 gallons.

Sizes of distributing mains: 12, 10, 8, 6, 4, and 3 inches.

Available head: 20 pounds (average); water-supply deficient.

Total length of distributing mains: 70 miles.

Number of water-takers: 2,400.

Consumption of water: About 150 gallons per head per day (estimated).

First cost of water-works: $700,000.

LAKE—Continued.

Average annual cost of maintenance and repairs: $18,000.

Number of fire-plugs: 300.

Design and dimensions of pumps and water-plungers: Made by Holly Manufacturing Company, piston-plunger, and, made by Knowles, plain plunger; 22 strokes per minute; pump-barrel, 9 by 20 inches.

Time pumps are run: Constantly.

Description of force-main: 8 miles long, 16 inches diameter, 60 pounds pressure on pumps.

Description of water-valves: Holly, foot-valves, 4 feet by 7 inches; Knowles, rubber, 4 inches.

Kind of power used: Steam.

Description of boilers: Tubular, 60 pounds pressure; fuel, Indiana block bituminous coal.

Description of engine: Compound, 52 strokes per minute; slide-valves: ordinary air-pump; jet-condenser.

Cost of engine and pumps: $50,000.

Duty of engine: 28,000,000 foot-pounds daily; 60,000,000 foot-pounds guaranteed.

Remarks: Water-works to point of distribution built and maintained in common with the town of Hyde Park, Illinois.

MOLINE:

Population: 7,800 inhabitants.

Style of corporation: Municipal.

Water obtained from: Mississippi river, above government dam.

Water first introduced: In 1877.

Description of main conduit: 500 feet long, 12 inches diameter; cast iron.

Discharging capacity: 100 pounds steam will discharge 1,000 gallons per minute.

Sizes of distributing mains: 8 and 4 inches.

Available head: 100 pounds (average).

Total length of distributing mains: 3,727 feet and 6,378 feet.

Number of water-takers: 52.

Consumption of water: 720,000 gallons in 24 hours (estimated).

First cost of water-works: $12,000.

Average annual cost of maintenance and repairs: $300.

Number of fire-plugs: 47.

Design and dimensions of pumps and water-plungers: One Knowles and two Worthington duplex; two plain plungers, 10 inches diameter, 24 inches stroke, 150 strokes per minute; pump-barrels, 10 inches each.

Time pumps are run: 24 hours per day.

Description of force-main: 50 pounds pressure on pumps.

Description of water-valves: Vulcanized rubber, 3 inches diameter, ⅜ inch lift.

Kind of power used: Steam.

Location of boilers: Located at saw-mill of Dunnock, Gould, & Co.

Description of engine: Simple, non-condensing; 18 inches diameter, 24 inches stroke, 150 strokes per minute; Knowles patent valves.

Cost of engine and pumps: $2,300.

Remarks: The advantage of pumping direct into distributing mains is perfect control of pressure; the disadvantage is that water is less pure.

RAVENSWOOD:

Population: 485 inhabitants.

Style of corporation: Municipal.

Water obtained from: Lake Michigan.

Water first introduced: In May, 1876.

Sizes of distributing mains: 14 to 4 inches.

Available head: 40 pounds (average).

Total length of distributing mains: 21 miles.

Consumption of water: 500,000 gallons per day (estimated).

First cost of water-works: $200,000.

Average annual cost of maintenance and repairs: $5,000.

Number of fire-plugs: 78.

RAVENSWOOD—Continued.
Design and dimensions of pump and water-plungers: Made by Flanders, Vergennes, Vermont; plain plungers, 5 to 35 strokes per minute; pump-barrels: No. 1, 20 by 14 inches; No. 2, 30 by 12 inches.
Time pump is run: Constantly.
Description of force-main: 25 miles long, 14 to 4 inches diameter.
Description of water-valves: Hard rubber.
Kind of power used: Steam.
Description of boilers: Two tubular, 16 feet long; 50 flues; 80 pounds pressure.
Description of engines: Condensing; one set 20 by 14 inches; one set Harris-Corliss, 20 by 14 inches; 20 strokes per minute; No. 1, slide-valves; two single-acting air-pumps; No. 2, Corliss valve, drop cut-off; one double-acting air-pump; jet-condenser.
Cost of engines and pump: $25,000.

ROCHELLE:
Population: 1,893 inhabitants.
Style of corporation: Municipal.
Water obtained from: Water-shed, fed by springs.
Capacity of reservoir: 7,000,000 gallons.
Water first introduced: In 1877.
Sizes of distributing mains: 8 and 6 inches.
Available head: 40 pounds (average).
Total length of distributing mains: 8,500 feet.
Number of water-takers: 70.
First cost of water-works: $16,000.
Average annual cost of maintenance and repairs: $2,000.
Number of fire-plugs: 24.
Design and dimensions of pumps and water-plungers: Two; made by Worthington; duplex, 16 by 10 by 10¼ inches; bucket-plunger, 4 inches; 10¼ inches; 300 strokes per minute.
Time pumps are run: 16 hours per day.
Description of force-main: 4,335 feet long.
Description of water-valves: Rubber and spiral springs, 2½ inches diameter; lift, small.
Kind of power used: Steam.
Description of boilers: One horizontal; 39 4-inch flues; 14 feet long, 50 inches diameter; one 50 horse-power Firmenich.
Description of engine: Non-condensing; 16 inches diameter, 10 inches stroke.
Cost of engine and pumps: $3,000.
Duty of engine: 800 gallons per minute each, daily; 1,000 gallons per minute guaranteed.

STOCKYARD STATION:
Population: 4,400 inhabitants.
Name of corporation: Town Lake (municipal).
Water obtained from: Lake Michigan.
Water first introduced: In 1874.
Description of main conduit: 16 inches diameter.
Discharging capacity: 5,000,000 gallons; 110 pounds pressure (average).
Sizes of distributing mains: 12, 10, 8, 6, 4, and 3 inches.
Available head: 20 pounds (average); water-supply deficient.
Total length of distributing mains: 70 miles.
Number of water-takers: 2,400.
Consumption of water: 150 gallons per head per day (estimated).
First cost of water-works: $750,000.
Average annual cost of maintenance and repairs: $18,000.
Number of fire-plugs: 300.
Design and dimensions of pumps and water-plungers: Made by Holly Manufacturing Company, piston-plunger; made by Knowles, plain plunger; 22 strokes per minute; pump-barrels, 9 by 20 inches.
Time pumps are run: Constantly.
Time spent in repairs: None.
Description of force-main: 8 miles long, 6 inches diameter; head, 60 pounds (average) on pumps.
Description of water-valves: Foot-valves—Holly, 4 by 7 inches; Knowles, rubber, 4 inches.

STOCKYARD STATION—Continued.
Kind of power used: Steam.
Description of boiler: Tubular, 60 pounds pressure; 7½ pounds water to 1 pound coal; fuel, Indiana block bituminous coal.
Description of engine: Compound; 52 strokes per minute; slide-valves; common air-pump; jet-condenser.
Cost of engine and pumps: $50,000.
Duty of engine: 28,000,000 gallons daily.
Remarks: The advantage of pumping direct to mains is the saving of stand-pipe.

SYCAMORE:
Population: 3,028 inhabitants.
Name of corporation: Sycamore Water-Works (municipal).
Water obtained from: Well.
Water first introduced: In 1876.
Size of distributing mains: 10 inches.
First cost of water-works: About $25,000.
Number of fire-plugs: 15.
Design of pump and water-plunger: Blake pump, Boston, Massachusetts, 1875.
Kind of power used: Steam.
Cost of engine and pump: $2,000.

INDIANA.

BRAZIL:
Population: 3,441 inhabitants.
Style of corporation: Municipal.
Water obtained from: Well.
Total area of water-shed available: 13 acres
Water first introduced: In 1875.
Description of reservoir: A well, 25 feet in diameter.
Size of distributing mains: 8 inches.
Total length of distributing mains: About 2½ miles.
Number of water-takers: About 50.
Consumption of water: 22 gallons per head per day (estimated).
First cost of water-works: $28,500.
Average annual cost of maintenance and repairs: About $1,400.
Number of fire-plugs: 22.
Design and dimensions of pump and water-plunger: Made by Deane Brothers, Indianapolis, Indiana; plain plunger, 10 inches diameter; 15 strokes per minute; pump-barrel, 10 inches diameter.
Time pump is run: 18 hours per day.
Time spent in repairs: 28 hours per year.
Description of water-valves: Gum; 6 inches diameter, 1¼ inch lift.
Kind of power used: Steam.
Description of boilers: Tubular, 14 feet long; 40 pounds pressure; fuel, the slack of block coal.
Description of engine: Non-condensing; 16 inches diameter, 18 inches stroke, 15 strokes per minute; throttle-valves.
Cost of engine and pump: About $12,000.

COLUMBUS:
Population: 4,813 inhabitants.
Name of corporation: Columbus Water-Works (municipal).
Water obtained from: White river.
Water first introduced: In 1871.
Sizes of distributing mains: 10, 8, and 6 inches.
Total length of distributing mains: 8 miles.
Number of water-takers: 200.
First cost of water-works: $80,000.
Average annual cost of maintenance and repairs: $5,000.
Filtering apparatus: Gallery, 500 feet long, 16 feet wide, 16 feet deep, filled with gravel, imbedded 4 feet below bottom of river; sides and top closed; no cleaning.
Number of fire-plugs: 80.
Design and dimensions of pump and water-plunger: Made by Holly Manufacturing Company, Lockport, New York; plain plunger, 12 inches diameter, 24 inches stroke, 19 to 20 strokes per minute.
Time pump is used: Constantly.
Time spent in repairs: 150 hours per year.

COLUMBUS—Continued.
Kind of power used: Steam.
Description of boilers: Two; 14 feet long, 48 inches diameter; 48 flues.
Description of engine: Condensing, simple; 14 inches diameter, 2 feet stroke, 40 strokes per minute; direct-acting slide-valves.
Cost of engine and pump: $45,000.

CONNERSVILLE:
Population: 3,228 inhabitants
Name of corporation: Connersville Hydraulic Company.
Water obtained from: White Water river.
Character and dimensions of dam: 600 feet long, 6 feet high; frame.
Water first introduced: In 1869.
Sizes of distributing mains: 8, 6, and 4 inches.
Available head: 18 feet (average).
Total length of distributing mains: About 4 miles.
Number of water-takers: 325.
Consumption of water: 1,000,000 gallons per day (estimated).
First cost of water-works: $42,000.
Average annual cost of maintenance and repairs: About $5,000.
Number of fire-plugs: 50.
Design and dimensions of pump and water-plunger: Double 8-inch rotary pump.
Time pump is run: Constantly.
Time spent in repairs: One month per year.
Description of force-main: 3 miles long, 8, 6, and 4 inches diameter; 20 pounds pressure on pump.
Kind of power used: Water.
Description of water-wheels: Two turbines, one Holly, and one Eclipse, 30 and 36 inches diameter, made by Pierce Manufacturing Company; 14 feet head, 150 revolutions per minute.
Remarks: Water is from canal, and, of course, not good for drinking, but answers the purpose it is generally put to.

EVANSVILLE:
Population: 29,280 inhabitants.
Name of corporation: Evansville Water-Works (municipal).
Water obtained from: Ohio river.
Water first introduced: June, 1872.
Description of main conduit: 2,300 feet long, 24 inches diameter; cast iron.
Sizes of distributing mains: 20 and 12 inches.
Total length of distributing mains: 25 miles.
Number of water-takers: 1,306.
First cost of water-works: $328,319 06.
Filtering system: Sand and gravel.
Number of fire-plugs: 228.
Design and dimensions of pump and water-plungers: Made by Holly Manufacturing Company, Lockport, New York; four bucket-plungers, 36 inches diameter, 18 inches stroke, double-acting, 16 strokes per minute; pump-barrel, 18 by 36 inches.
Time pump is run: Constantly.
Description of force-main: Head, 154 feet on pump.
Description of water-valves: Four; rubber; 8 inches diameter, 1¼ inch lift.
Kind of power used: Steam.
Description of boilers: Four; 16 feet long, 4 feet diameter; 12 flues, 6 inches each; 90 pounds pressure; 8.85 pounds of water to 1 pound coal; fuel, anthracite coal.
Description of engine: Compound condensing; high-pressure cylinder 24 inches diameter, low-pressure cylinder 41 inches diameter, 36 inches stroke; balanced puppet operated by cams; Buckley injector condenser.
Cost of engine and pump: $26,000.
Duty of engine: 88,000,000 foot-pounds daily; 80,000,000 foot-pounds guaranteed.

LOGANSPORT:
Population: 11,198 inhabitants.
Style of corporation: Municipal.
Water obtained from: Eel river.
Total area of water-shed available: 3,600 square miles.

LOGANSPORT—Continued.
Character and dimension of dam: 500 feet long, 6 feet deep (average); wooden.
Cost of dam: $7,000.
Water first introduced: In 1876.
Description of main conduit: 2,000 feet long, 20 inches diameter; cast iron.
Discharging capacity: 3,000,000 gallons per 24 hours.
Sizes of distributing mains: 20, 16, 12, 10, 8, 6, 4, and 2 inches.
Available head: 40 pounds (average).
Total length of distributing mains: 10½ miles.
Number of water-takers: 400.
Consumption of water: 500,000 gallons per day (estimated).
First cost of water-works: $185,000.
Average annual cost of maintenance and repairs: $25,000.
Number of fire-plugs: 84.
Design and dimensions of pumps and water-plungers: Made by Cope & Maxwell, Hamilton, Ohio; 4 piston-pumps, 11 inches diameter, 24 inches stroke; pump-barrel, 11 by 24 inches.
Time pumps are run: Constantly.
Description of water-valves: Rubber, 6½ by 1 inch thick.
Kind of power used: Steam and water.
Description of water-wheels: 3 Little Giant turbines; two 54 inches, one 42 inches; 11 feet head.
Description of boilers: Two; 12 feet long, 62 inches diameter; 100 tubes, 2½ inches diameter.
Description of engines: Compound; two 10 inches and two 20 inches, 8-inch crank, 14 strokes per minute; slide eccentric valves.
Cost of engines and pumps: $21,000.
Duty of engines: 8,370,535 foot-pounds daily; 4 tons coal per day.

MARION:
Population: 3,182 inhabitants.
Name of corporation: Marion Water-Works (municipal).
Water obtained from: Flowing river.
Water first introduced: In 1877.
Sizes of distributing mains: 12, 8, 6, and 4 inches.
Available head: 40 pounds (average).
Total length of distributing mains: 7 miles.
Number of water-takers: 300.
Consumption of water: 336,000 gallons per day (estimated).
First cost of water-works: $34,000.
Number of fire-plugs: 44.
Design and dimensions of pump and water-plungers: Made by Deane Brothers, Indianapolis, Indiana; two plain plungers, 10 inches diameter, 14½ inches stroke, 8 strokes per minute; pump-barrel, 14½ by 10 inches.
Time pump is run: Constantly.
Description of force-main: ½ mile long, 12 inches diameter, 40 pounds pressure on pumps.
Description of water-valves: Rubber, 6 inches.
Kind of power used: Steam.
Description of boilers: 13 feet long, 48 inches diameter, 35 pounds pressure; fuel, Pittsburgh coal.
Description of engine: Duplex, 18 inches diameter, 14 inches stroke; 8 strokes per minute; independent cut-off, double valve.
Cost of engine and pump: $4,000.
Duty of engine: 465,000 gallons per day.

UNION CITY:
Population: 2,478 inhabitants.
Style of corporation: Municipal.
Water obtained from: Well.
Water first introduced: January, 1874.
Description of main conduit: 10 inches diameter; wood, coated with coal-tar or asphaltum and bound with strap-iron.
Sizes of distributing mains: 10, 8, 6, and 4 inches.
Available head: 60 to 70 pounds.
Number of water-takers: 167.
Consumption of water: 150,000 gallons per day (estimated).
First cost of water-works: $50,000.

UNION CITY—Continued.

Average annual cost of maintenance and repairs: $2,700 to $3,500.
Number of fire-plugs: 20.
Design and dimensions of pump and water-plungers: Deane Brothers, makers, Indianapolis, 1873; plain plungers.
Time pump is run: Constantly.
Kind of power used: Steam.
Description of boilers: Tubular, 60 to 70 pounds pressure; fuel, Hocking Valley and Pittsburgh coal.

IOWA.

CEDAR RAPIDS:

Population: 10,104 inhabitants.
Name of corporation: Cedar Rapids Water Company (private).
Water obtained from: Cedar river.
Water first introduced: In 1875.
Sizes of distributing mains: 16 to 4 inches.
Total length of distributing mains: 7¾ miles.
Number of water-takers: 330.
Consumption of water: 600,000 gallons per day (estimated).
First cost of water-works: $119,245.
Average annual cost of maintenance and repairs: $13,000.
Number of fire-plugs: 76.
Design and dimensions of pumps and water-plungers: Made by McGowan Pump Company, Cincinnati, Ohio, 1875; 4 duplex double-acting plungers; 2 cylinders, 30 inches diameter, 30 inches stroke; 2 cylinders, 10 inches diameter, 24 inches stroke; two 20 and two 40 strokes per minute; pump-barrels, 10 by 24 inches and 14 by 30 inches.
Time pumps are run: Constantly.
Time spent in repairs: 250 hours per year.
Description of force-main: 1,600 feet long, 16 inches diameter, 60 pounds pressure on pumps.
Description of water-valves: Disk, in 2 cylinders, 8 inches diameter, 1 inch lift; clapped in 2 cylinders, 6 feet by 9 inches, 3 inches lift.
Kind of power used: Steam.
Description of boilers: Two, tubular, 14 feet long, 60 inches diameter, 70 pounds pressure; fuel, bituminous coal.
Description of engines: One compound condensing, 20½ by 30 inches, and 28 by 30 inches; 20 strokes per minute; 1 piston-valve; 1 condensing or non-condensing, 16 inches diameter, 24 inches stroke, 40 strokes per minute; 1 slide-valve; piston air-pump, and jet-condenser, 100 gallons per minute.
Cost of engines and pumps: $21,760.
Duty of engines: 600,000 gallons with 60 pounds pressure daily; 4,000,000 gallons per 24 hours guaranteed.
Remarks: The advantage and disadvantage of pumping direct to mains are best system for fire purposes, but more expensive for general use.

DAVENPORT:

Population: 21,831 inhabitants:
Name of corporation: Davenport Water Company (private).
Water obtained from: Mississippi river.
Water first introduced: In 1874.
Description of main conduit: 150 feet long, square, and arched on top; brick; extends into river.
Sizes of distributing mains: 14, 12, 10, 8, 6, and 4 inches.
Available head: 80 to 90 pounds.
Total length of distributing mains: 22 miles.
Number of water-takers: 650.
Consumption of water: 3,000,000 gallons per day (estimated).
First cost of water-works: About $500,000.
Average annual cost of maintenance and repairs: About $26,000.
Number of fire-plugs: 242.
Design and dimensions of pump and water-plungers: Made by Todd & Rafferty, Paterson, New Jersey, 1874; two plain plungers, 17 inches diameter, 6 feet stroke, double-acting, 6 to 12 strokes per minute; pump-barrel, 17 inches diameter.

DAVENPORT—Continued.

Time pumps are run: Constantly.
Description of force-main: 14 inches diameter, 80 to 90 pounds pressure on pump.
Description of water-valves: Rubber disks, 14 inches diameter, ¼ to 1 inch lift.
Kind of power used: Steam.
Description of boilers: Two-flue, 24 feet long, 52 inches diameter, 75 pounds pressure; 5 pounds water to 1 pound coal; fuel, bituminous coal.
Description of engine: Non-condensing, 24 inches diameter, 36 inches stroke, 60 strokes per minute; slide-valves.

DES MOINES:

Population: 22,408 inhabitants.
Name of corporation: Des Moines Water-Works Company (private).
Water obtained from: Raccoon river.
Water first introduced: In 1872.
Description of main conduit: 1,000 feet long, 16 inches diameter; iron.
Sizes of distributing mains: 16, 12, 10, 8, 6, and 4 inches.
Total length of distributing mains: 20 miles.
Number of water-takers: 1,200.
Consumption of water: 2,000,000 gallons per day (estimated).
First cost of water-works: $350,000.
Filtering apparatus: One 14 inches diameter and one 8 inches diameter, made of boiler-iron.
Number of fire-plugs: 187.
Design and dimensions of pumps and water-plungers: Made by Holly Manufacturing Company, Lockport, New York, in 1871; 8 bucket-plungers, 14 inches diameter, 12 inches stroke; pump-barrels, 14 inches diameter; 4 rotary pumps, 12 by 19 inches; 80 to 150 pounds pressure on pumps.
Time pumps are run: Constantly.
Description of water-valves: Rubber, 13 inches diameter, 2 inches lift.
Kind of power used: Steam.
Description of boilers: 2 vertical and 2 horizontal; 70 pounds pressure; fuel, bituminous coal.
Description of engine: Interchangeable, 14 inches diameter, 24 inches stroke, Holly valve; air-pump, 14 by 14 inches; surface-condenser, 12 feet high, 30 inches diameter.
Cost of engine and pumps: $50,000.

KEOKUK:

Population: 12,117 inhabitants.
Name of corporation: Keokuk Water-Works (private).
Water obtained from: Mississippi river.
Water first introduced: July, 1878.
Description of main conduit: Length 250 feet, diameter 20 inches; cast iron,
Discharging capacity: 2,220,000 gallons per 24 hours.
Sizes of distributing mains: 14 to 6 inches.
Available head: 35 to 75 pounds.
Total length of distributing mains. 11 miles.
Number of water-takers: 396.
Consumption of water: 70 gallons per head per day (estimated).
First cost of water-works: $100,000.
Average annual cost of maintenance and repairs: $5,000.
Filtering apparatus: Size, 60 feet long, 15 feet deep; filled with fine and coarse sand, gravel, charcoal, and broken rock, in layers; cleaned once in two years.
Number of fire-plugs: 76.
Design and dimensions of pump and water-plungers: Made by Holly Manufacturing Company, Lockport, New York, in in 1878; four plain plungers, 8 inches diameter, 22 inches stroke; pump-barrel, 8 inches diameter.
Time pump is run: Constantly.
Description of force-main: 14 inches diameter, 60 to 120 pounds pressure on pump.
Kind of power used: Steam.

KEOKUK—Continued.
Description of boilers: Two; 16 feet long, 5 feet diameter; 34 flues, 3¼ inches diameter, 60 to 80 pounds pressure; 7 to 8 pounds water to 1 pound coal; fuel, Iowa bituminous coal.
Description of engines: Interchangeable, 4 cylinders, 14½ inches diameter, 22 inches stroke; slide-valves operated by eccentric; air-pump, 14 by 12 inches; condenser, 12,200 cubic inches.
Cost of engine and pump: $20,000.
Duty of engine: 400,000 gallons daily.
Remarks: The advantage and disadvantage of pumping direct to mains are control of pressure, but it is wearing on machinery.

MARENGO:
Population: 1,738 inhabitants.
Style of corporation: Municipal.
Water obtained from: Mill-dam.
Water first introduced: In 1875.
Sizes of distributing mains: 6 and 4 inches.
Total length of distributing mains: 1½ mile.
First cost of water-works: $8,000.
Average annual cost of maintenance and repairs: $100.
Number of fire-plugs: 10.
Design of pump and water-plunger: Made by Worthington, New York.
Kind of power used: Water.
Description of water-wheels: Two turbines.

MARSHALLTOWN:
Population: 6,240 inhabitants.
Name of corporation: Marshalltown Water-Works (municipal).
Water obtained from: Iowa river.
Water first introduced: October, 1876.
Sizes of distributing mains: 12 to 4 inches.
Available head: 35 pounds (average).
Total length of distributing mains: 7.9 miles.
Number of water-takers: 425.
Consumption of water: 250,000 gallons per day (estimated).
First cost of water-works: $46,500.
Average annual cost of maintenance and repairs: $3,380.
Filtering apparatus: A large well, 17 by 34 feet; charcoal and gravel, 2 feet thick.
Number of fire-plugs: 69.
Design and dimensions of pump and water-plunger: Made by Knowles, Warren, Massachusetts; plain plunger, 12 inches diameter, 24 inches stroke.
Time pump is used: Constantly.
Description of water-valves: Rubber, 3½ inches diameter, ¼ inch lift.
Kind of power used: Steam.
Description of boilers: Two, tubular, 14 feet long, 48 inches diameter; 52 tubes, 3 inches diameter, 75 pounds pressure; fuel, soft coal.
Description of engine: Simple, 22 by 24 inches, 1 to 80 strokes per minute; puppet- and slide-valves.
Cost of engine and pump: $5,000.

MONTICELLO:
Population: 1,877 inhabitants.
Style of corporation: Municipal.
Water obtained from: Artesian well.
Capacity of reservoir: 250,000 gallons.
Cost of dam: $1,000.
Water first introduced: October, 1879.
Description of main conduit: ½ mile long, 8 inches diameter; cast iron.
Sizes of distributing mains: 8, 6, and 4 inches.
Available head: 120 feet (average).
Total length of distributing mains: 2 miles.
Number of water-takers: 65.
Consumption of water: 12,000 gallons per day (estimated).
First cost of water-works: $15,000.
Average annual cost of maintenance and repairs: $900.
Number of fire-plugs: 20.

MONTICELLO—Continued.
Design and dimensions of pump and water-plunger: Made by Blake & Co., Boston, Massachusetts; plain plunger, 8 inches diameter, 12 inches stroke, 80 to 120 strokes per minute; pump-barrel, 8 by 12 inches.
Time pump is run: 20 to 25 hours per week.
Time spent in repairs: 250 hours per year.
Description of force-main: Head, 125 feet on pump.
Description of water-valves: Rubber, 3 inches diameter.
Kind of power used: Steam.
Description of boilers: Upright, 10 feet high, 4 feet diameter; fuel, wood.
Description of engine: Non-condensing, simple, 14 inches diameter, 12 inches stroke, 90 strokes per minute.
Cost of engine and pump: $1,000.

OSKALOOSA:
Population: 4,593 inhabitants.
Name of corporation: Oskaloosa Water Company (private).
Water obtained from: Skunk river.
Water first introduced: August, 1880.
Description of main conduit: 10 miles long, 10 inches diameter; cast iron.
Discharging capacity: 2,000,000 gallons per day, 60 to 80 pounds pressure.
Sizes of distributing mains: 8, 6, and 4 inches.
Available head: 35 pounds (average).
Total length of distributing mains: 4½ miles.
Number of water-takers: 60.
First cost of water-works: $102,000.
Filtering apparatus: Pit in solid rock, 40 by 15 feet, 3 feet below bed of stream; charcoal, sand, and gravel in alternate layers; cleaned once a year.
Number of fire-plugs: 49.
Design and dimensions of pump and water-plunger: Made by Holly Manufacturing Company, Lockport, New York; plain plunger; pump-barrel, 10 inches diameter.
Time pump is run: Constantly.
Description of force-main: 4 miles long, 10 inches diameter; head, 114 feet on pump.
Description of water-valves: Iron and rubber.
Kind of power used: Steam.
Description of boilers: 18 feet long, 52 inches diameter; 40 tubes.
Description of engine: One quadruplex compound condensing; 4 pumps; 1 duplex high-pressure pump.

KANSAS.

EMPORIA:
Population: 4,631 inhabitants.
Name of corporation: Emporia Water-Works (municipal).
Water obtained from: Cottonwood river.
Total area of water-shed available: 1 mile.
Water first introduced: June, 1880.
Description of main conduit: 8 inches diameter.
Discharging capacity: 2,000,000 gallons per day; 100 pounds pressure (average).
Sizes of distributing mains: 12 to 8 inches.
Available head: Variable.
Total length of distributing mains: 11½ miles.
Number of water-takers: 104.
Consumption of water: 10,000 gallons per day (estimated).
First cost of water-works: $62,500.
Average annual cost of maintenance and repairs: $4,500.
Number of fire-plugs: 47.
Design and dimensions of pump and water-plunger: Made by Holly Manufacturing Company, Lockport, New York; plain plunger, 6 inches diameter, 21 inches stroke, 12 strokes per minute; pump-barrel, 6 by 21 inches.
Time pump is run: Constantly.
Description of force-main: 5,000 feet long, 8 inches diameter, 45 pounds pressure on pump.
Description of water-valves: Hinge, 4 by 6 inches, ⅝ inch lift.

EMPORIA—Continued.

Kind of power used: Steam.
Description of boilers: Tubular, 54 inches diameter, 50 pounds pressure; fuel, Little Pittsburgh coal.
Description of engine: Condensing compound, 16 by 21 inches, 6 strokes per minute; slide-valves by eccentric; surface condenser.
Cost of engine and pump: $15,000.
Advantage of pumping direct into main: Economy in fuel, and control of pressure.

KENTUCKY.

OWENSBOROUGH:

Population: 6,231 inhabitants.
Name of corporation: Owensborough Water Company (private).
Water obtained from: Ohio river.
Water first introduced: July, 1879.
Sizes of distributing mains: 10, 8, 6, 4, and 3 inches.
Available head: 80 feet (average).
Total length of distributing mains: 9 miles and 570 feet.
Number of water-takers: 254.
Consumption of water: 10 gallons per day per head (estimated).
First cost of water-works: $80,000.
Average annual cost of maintenance and repairs: $6,000.
Number of fire-plugs: 74.
Design and dimensions of pump and water-plungers: Made by Holly Manufacturing Company, Lockport, New York, in 1879; two plain and solid plungers, 14 inches diameter, 30 inches stroke, 10 strokes per minute; pump-barrel, 14 by 36 inches.
Time pump is run: Constantly.
Time spent in repairs: 7 days per year.
Description of force-main: 300 feet long, 10 inches diameter, 40 to 45 pounds pressure on pump.
Description of water-valves: Hinge or gate, 10 degrees from horizontal; size, 12 by 5 inches; 1¼ inch lift.
Kind of power used: Steam.
Description of boilers: Tubular, 18 feet long, 5 feet diameter; evaporation, 2,100 pounds water per hour with 220 pounds coal.
Description of engine: Non-condensing or condensing; 25 inches diameter, 30 inches stroke, 20 strokes per minute; throttle-valve; horizontal air-pump, 9 by 12; Holly condenser.
Cost of engine and pump: $15,000.
Duty of engine: 75,000 gallons of water, daily; 2,000,000 gallons guaranteed.
Disadvantage of pumping direct to main: Not economical, either in labor or fuel.

MASSACHUSETTS.

TAUNTON:

Population: 21,213 inhabitants.
Name of corporation: Taunton Water-Works (municipal).
Water obtained from: Taunton river.
Water first introduced: December, 1876.
Sizes of distributing mains: 20, 16, 12, 10, 8, 6, and 4 inches.
Available head: 80 feet.
Total length of distributing mains: 35 miles.
Number of water-takers: 1,800.
Consumption of water: 510,261 gallons per day (exact).
First cost of water-works: $250,000.
Average annual cost of maintenance and repairs: About $9,000.
Filtering system: Old basin is a canal 400 feet long, 100 feet wide on top; inner slope, 2 to 1; bottom 8 feet below mean water-mark. New basin is an egg-shaped conduit, laid along river, distant 30 feet; supplied by driven wells; bricks laid in hydraulic cement, with end-joints left open and uncemented material, gravel.

TAUNTON—Continued.

Number of fire-plugs: 320.
Design and dimensions of pumps and water-plungers: Made by Holly Manufacturing Company, Lockport, New York; 4 plain plungers, 9⅝ inches diameter, 24 inches stroke; strokes per minute according to demand; pump-barrel, 9⅝ inches diameter.
Time pumps are run: Constantly.
Description of water-valves: Cylindrical; plugs, iron stems, covered with leather, 1¼ inch diameter, ¼ inch lift.
Kind of power used: Steam.
Description of boilers: Three tubular, 16 feet long, 60 inches diameter; 54 tubes, 3¼ inches diameter; 80 pounds pressure; fuel, Hazleton Lehigh egg coal.
Description of engine: Compound, 14 inches diameter, 24 inches stroke. Two rotary pumps, 20½ inches diameter, 30 inches stroke; strokes per minute variable.
Cost of engine and pumps: $62,000.
Duty of engine: 37,311,024 foot-pounds daily; 40,000,000 foot-pounds guaranteed.
Advantage of pumping direct into mains: Very best protection against fire. Extraordinary power can be had almost instantly.

MICHIGAN.

ALLEGAN:

Population: 2,305 inhabitants.
Style of corporation: Municipal.
Water obtained from: Wells.
Water first introduced: In 1871.
Description of main conduit: 12 and 4 inches diameter.
Sizes of distributing mains: 12 to 4 inches.
Available head: 60 feet (average).
Total length of distributing mains: 3 miles.
Number of water-takers: 150.
Consumption of water: 43,200 gallons per day (exact).
First cost of water-works: $50,000.
Average annual cost of maintenance and repairs: $1,500.
Number of fire-plugs; 30.
Design of pump and water-plungers: Made by Holly Manufacturing Company, Lockport, New York; rotary pump, 60 strokes per minute.
Time pump is run: Constantly.
Kind of power used: Water.
Description of water-wheels: Two Holly turbines, 8 feet head, 60 revolutions per minute.
Cost of engine and pump: $12,000.
Advantage of pumping direct into mains: Keeps pressure on.

ALPENA:

Population: 6,153 inhabitants.
Name of corporation: Alpena City Water-Works (private).
Water obtained from: Lake Huron.
Water first introduced: October, 1879.
Description of main conduit: Wood.
Sizes of distributing mains: 16, 12, 10, 8, 6, and 4 inches
Total length of distributing mains: 50,419 feet.
Number of water-takers: 250.
First cost of water-works: $56,000.
Average annual cost of maintenance and repairs: $2,000.
Number of fire-plugs: 80.
Design of pump and water-plungers: Made by Holly Manufacturing Company, Lockport, New York.
Time pump is run: Constantly.
Time spent in repairs: None.
Kind of power used: Water.
Description of water-wheels: One 50-inch and one 84-inch Leffel; one duplex pump, 2 by 9 by 18 inches; two Holly rotary No. 10.

BAY CITY:

Population: 20,693 inhabitants.
Style of corporation: Municipal.
Water obtained from: Saginaw bay.
Water first introduced: December, 1872.

BAY CITY—Continued.

Description of main conduit: $4\frac{880}{5280}$ miles long, 30 and 18 inches diameter; wooden staves, 3 inches thick, banded together every 2 feet with elm bands, laid in lengths of 8 feet.
Discharging capacity: 5,000,000 gallons in 24 hours; head, 10 feet (average).
Sizes of distributing mains: 16, 12, 10, 8, 6, and 4 inches.
Available head: About 60 feet (average).
Total length of distributing mains: 19½ miles.
Number of water-takers: 800.
Consumption of water: 2,266,000 gallons per day (exact).
First cost of water-works: $365,000.
Average annual cost of maintenance and repairs: $10,000.
Number of fire-plugs: 138.
Design and dimensions of pumps and water-plungers: Made by Holly Manufacturing Company, Lockport, New York, in 1872; 4 double-acting pistons, 9 inches diameter, 24 inches stroke, 30 strokes per minute; pump-barrel, 9 by 24 inches, two rotary; 40 pounds pressure on pumps.
Time pumps are run: Constantly.
Description of water-valves: Hinged, packed with leather, 6 by 10 inches.
Kind of power used: Steam.
Description of boilers: Horizontal tubular, 16 feet long, 5½ feet diameter, 70 pounds pressure; fuel, pine slabs.
Description of engines: Simple, compound condensing or non-condensing at will—14 by 24 inches, 140 strokes per minute; one high-pressure non-condensing, 18 and 22 inches, 320 strokes per minute; plain slide-valves, automatic cut-off, worked by cams; single-acting air-pump, 14 inches diameter, 24 inches stroke; jet-condenser.
Cost of engines and pumps: $39,000.
Duty of engines: 40,000,000 foot-pounds daily.
Advantage of pumping direct into mains: Control of pressure.

BIG RAPIDS:

Population: 3,552 inhabitants.
Name of corporation: Big Rapids Water-Works (municipal).
Water obtained from: Muskegon river.
Water first introduced: In 1871.
Sizes of distributing mains: 8, 6, and 4 inches.
Available head: Domestic purposes, 65 pounds pressure (average); fire purposes, 100 pounds pressure (average).
Total length of distributing mains: 3¼ miles.
Number of water-takers: 200.
Consumption of water: 22,000,000 gallons per month (estimated).
First cost of water-works: $65,000.
Average annual cost of maintenance and repairs: $3,500.
Number of fire-plugs: 24.
Design and dimensions of pump and water-plungers: Made by Holly Manufacturing Company, Lockport, New York, and two Blake (New York) plain plungers; 5 to 25 strokes per minute; pump-barrels, Blake, 14 by 12 inches and 19 by 12 inches.
Time pump is run: Constantly.
Description of water-valves: Rubber, 3 inches size, ¼ inch lift.
Kind of power used: Steam.
Description of boilers: 10 feet long, 5 feet diameter; fuel, pine wood.
Description of engines: Holly compound, 10 inches diameter, 24 inches stroke; large Blake, 20 inches diameter, 24 inches stroke; small Blake, 12 inches diameter, 14 inches stroke; 5 to 150 strokes per minute; D-valves; Holly air-pump.
Cost of engines and pump: $12,000.
Duty of engines: 2,000,000 gallons in 24 hours guaranteed.

CADILLAC:

Population: 2,213 inhabitants.
Name of corporation: Cadillac City Water-Works (private).
Water obtained from: Clam lake.

CADILLAC—Continued.

Total area of water-shed available: 200 square miles.
Water first introduced: In 1879.
Sizes of distributing mains: 6 and 4 inches.
Available head: 60 pounds (average).
Total length of distributing mains: 3 miles.
Number of water-takers: 400.
First cost of water-works: $15,000.
Average cost of maintenance and repairs: $1,010.
Number of fire-plugs: 14.
Design and dimensions of pump and water-plungers: Made by Dixon, Ferrisburg, Michigan, 1879; plain plungers, one 10 by 24 inches and one 6½ by 12 inches; small, 200 strokes per minute; large, 140 strokes per minute; pump-barrels, 6½ by 12 inches and 9 by 24 inches.
Time pump is run: Constantly.
Description of water-valves: Rubber.
Kind of power used: Steam.
Description of boilers: Two tubular, 10 feet long, 44 inches diameter; 12 feet long, 60 inches diameter; fuel, wood.
Description of engines: Simple, non-condensing; one 18 by 24 inches and one 12 by 12 inches; 140 and 200 strokes per minute; one exhaust- and one slide-valve, operated by puppet-arm.
Cost of engines and pump: $2,000.

CONSTANTINE:

Population: 1,405 inhabitants.
Style of corporation: Municipal.
Water obtained from: Fawn river.
Water first introduced: In 1878.
Size of distributing mains: 10 inches.
Total length of distributing mains: 1 mile.
First cost of water-works: $5,000.
Average annual cost of maintenance and repairs: About $100.
Number of fire-plugs: 7.
Design and dimensions of pump and water-plunger: Ferry pump, built at Ottier Iron Works, Ferrisburg, Michigan, in 1878; plunger, 9 inches diameter, 18 inches stroke, 80 strokes per minute; pump-barrel, 9 inches diameter.
Time pump is run: Constantly.
Description of force-main: 1 mile long, 10 inches diameter; head 60 feet on pump.
Description of water-valves: Common lap, 6 by 3 inches.
Kind of power used: Water.
Description of water-wheels: Two Leffel turbines, 36 and 42 inches diameter, 15 feet head, 120 revolutions per minute.

EAST SAGINAW:

Population: 19,016 inhabitants.
Name of corporation: East Saginaw Water-Works (municipal).
Water obtained from: Saginaw river.
Water first introduced: January, 1874.
Description of main conduit: 585 feet long, 30 inches diameter; wood.
Sizes of distributing mains: 16 to 2 inches.
Available head: 40 pounds (average).
Total length of distributing mains: $21\frac{1515}{5280}$ miles.
Number of water-takers: 800.
Consumption of water: 72 gallons per head per day (estimated).
First cost of water-works: $300,000.
Average annual cost of maintenance and repairs: $8,571.
Number of fire-plugs: 149.
Design and dimensions of pump and water-plungers: Made by Holly Manufacturing Company, Lockport, New York; 4 plain plungers, 9 inches diameter, 24 inches stroke, 20 strokes per minute; pump-barrel, 24 by 9 inches.
Time pump is run: Constantly.
Description of force-main: 40 pounds pressure on pump.
Description of water-valves: Leather, 5 by 9 inches, 2 inches lift.
Kind of power used: Steam.
Description of boilers: Three horizontal, 16 feet long, 5 feet diameter; 58 flues, 3½ inches diameter.

EAST SAGINAW—Continued.

Description of engines: Two pair, double-cylinder, condensing, 21 strokes per minute; slide-valves operated by eccentric; one Holly rotary, 150 horse-power.

Cost of pump and engines: $32,000.

HOLLY:

Population: 1,443 inhabitants.
Style of corporation: Municipal.
Water obtained from: Mill-pond and Shiawassee river.
Water first introduced: In 1880.
Sizes of distributing mains: 8 and 6 inches.
Total length of distributing mains: About 2 miles.
First cost of water-works: $9,000.
Average annual cost of maintenance and repairs: $1,300.
Number of fire-plugs: 16.
Design and dimensions of pump and water-plungers: Pattee & Perkins patent, Sterling, Illinois; two plain plungers, 7 inches diameter, 12 inches stroke, 100 strokes per minute; pump-barrel, 12 inches diameter.
Time pump is run: Constantly.
Description of water-valves: Rubber.
Kind of power used: Steam.
Description of boilers: 14 feet long, 3 feet diameter, 30 pounds pressure; fuel, bituminous coal.
Description of engine: Simple, non-condensing, 12 by 14 inches; slide-valves worked by eccentric.
Cost of engine and pump: $1,000.
Remarks: The only impurities are from vegetable matter.

JACKSON:

Population: 16,105 inhabitants.
Name of corporation: Jackson City Water-Works (municipal).
Water obtained from: Artesian wells.
Water first introduced: In 1870.
Sizes of distributing mains: 15, 12, 6, and 4 inches.
Available head: 40 pounds (average).
Total length of distributing mains: 12 miles.
Number of water-takers: About 600.
Consumption of water: 782,203 gallons per day (estimated).
First cost of water-works: $140,000.
Average annual cost of maintenance and repairs: $6,800.
Number of fire-plugs: 85.
Design and dimensions of pumps and water-plungers: Two rotary and piston, made by Holly Manufacturing Company, Lockport, New York, in 1870–'72; two piston plungers, 27 by 10 inches, 30 strokes per minute; pump-barrel, 10 inches diameter.
Time pumps are run: Constantly.
Description of force-main: 12 miles long, 15 to 4 inches diameter; head, 115 feet on pumps.
Description of water-valves: Flap, 4½ by 10 inches, ½ inch lift.
Kind of power used: Steam.
Description of boilers: Tubular, 14 feet long, 5 feet diameter; fuel, bituminous coal.
Description of engines: Two condensing, 16 inches diameter, 27 inches stroke, 100 strokes per minute; common slide-valves, with puppet cut-off; simple acting air-pump, 14 inches stroke, half of area of cylinder; one rotary 150 horse-power.
Cost of engines and pumps: $40,000.
Duty of engines: 15,021,400 foot-pounds daily.

MARQUETTE:

Population: 4,690 inhabitants.
Style of corporation: Municipal.
Water obtained from: Lake Superior.
Water first introduced: In 1870.
Description of main conduit: 200 feet long, 24 inches diameter; iron.
Sizes of distributing mains: 8, 6, 4, 3, 2, and 1¼ inches.
Available head: 20 to 50 pounds; water-supply deficient.
Total length of distributing mains: 34,500 feet.
Number of water-takers: 550.

MARQUETTE—Continued.

Consumption of water: 100 gallons per head per day (estimated).
First cost of water-works: $100,000.
Average annual cost of maintenance and repairs: $6,500.
Number of fire-plugs: 53.
Design and dimensions of pumps and water-plungers: One set Holly in 1869; one set Murrett in 1873; plungers double and single bucket, 6–8 inches Holly, 8–12 inches Murrett; 10 to 15 strokes per minute; pump-barrel, 12 by 12 inches.
Time pumps are run: Constantly.
Time spent in repairs: 7 days per year.
Description of force-main: 5,000 feet long, 8 inches diameter, 80 pounds pressure on pumps.
Description of water-valves: Leather foot; rubber bucket, 12 inches, 4 feet lift.
Kind of power used: Steam.
Description of boilers: One upright flue, 10 feet long, 7 feet diameter; one horizontal flue, 14 feet long, 5 feet diameter.
Description of engines: Simple; one 14 by 24 inches, 50 to 100 strokes per minute; one 18 by 24 inches, 30 to 50 strokes per minute.
Cost of engines and pumps: $43,000.

MUSKEGON:

Population: 11,262 inhabitants.
Name of corporation: Muskegon City Water-Works (municipal).
Water obtained from: Springs.
Total area of water-shed available: 30 acres.
Capacity of reservoir: 5,500,000 gallons.
Water first introduced: In 1875.
Sizes of distributing mains: 16, 12, 8, 6, and 4 inches.
Available head: 40 pounds (average).
Total length of distributing mains: 15 miles.
Number of water-takers: 482.
Consumption of water: 70 gallons per head per day (estimated).
First cost of water-works: $160,000.
Average annual cost of maintenance and repairs: $4,000.
Number of fire-plugs: 184.
Design and dimensions of pump and water-plungers: Flanders, made at Vergennes, Vermont; two sets plain duplex plungers, 14 by 20 inches, 3 to 24 strokes per minute.
Time pump is run: Constantly.
Time spent in repairs: 80 hours per year.
Description of force-main: 2,115 feet long, 16 inches diameter, 40 to 70 pounds pressure on pump.
Description of water-valves: Hard rubber, 6 inches.
Kind of power used: Steam.
Description of boilers: Two tubular, 16 feet long, 68 inches diameter, 70 pounds pressure; fuel, pine slabs.
Description of engine: Simple; 16 by 32 inches, 24 to 102 strokes per minute; globe-valves.
Cost of pump and engine: $27,000.
Remark: Only trouble is from vegetable matter in reservoir.

PORT HURON:

Population: 8,883 inhabitants.
Style of corporation: Municipal.
Water obtained from: Saint Clair river.
Water first introduced: In 1872.
Sizes of distributing mains: 16 to 2 inches.
Available head: 70 feet (average).
Total length of distributing mains: 18 miles.
Number of water-takers: About 1,200.
Consumption of water: 500,000 gallons per day (estimated).
First cost of water-works: $170,000.
Average annual cost of maintenance and repairs: About $6,500.
Number of fire-plugs: 108.
Design and dimensions of pump and water-plungers: Made by Holly Manufacturing Company, Lockport, New York; 4 plain plungers, 9 inches diameter, 24 inches stroke, 18 strokes per minute; pump-barrel, 9 by 24 inches.

PORT HURON—Continued.
Time pump is run: Constantly.
Description of force-main: 30 pounds pressure on pumps.
Description of water-valves: Leather hinge, 3¼ by 7 inches.
Kind of power used: Steam.
Description of boilers: Two tubular, 16 feet long, 5 feet diameter; 72 tubes, 4 inches each; 25 pounds pressure; fuel, bituminous coal..
Description of engine: Condensing or compound, at will; 4 cylinders, 14 by 24 inches, each, 80 strokes per minute; slide-valves with variable cut-off; common bucket air-pump, 14 by 16 inches; jet-condenser.
Cost of engine and pump: $25,000.

SAGINAW:
Population: 10,525 inhabitants.
Name of corporation: Saginaw Water-Works (municipal).
Water first introduced: In 1872.
Sizes of distributing mains: 16, 10, 8, 6, and 4 inches.
Available head: 45 pounds (average).
Total length of distributing mains: 8½ miles.
Number of water-takers: 250.
Consumption of water: 1,000,000 gallons per day (estimated).
First cost of water-works: $150,000.
Average annual cost of maintenance and repairs: $8,500.
Number of fire-plugs: 124.
Design and dimensions of pumps and water-plungers: Made by Holly Manufacturing Company, Lockport, New York; 4 plain piston-plungers, 9 inches diameter, 24 inches stroke, 18 to 60 strokes per minute; pump-barrel, 9 by 24 inches, double-acting; two rotary pumps No. 10.
Time pumps are run: Constantly.
Description of water-valves: Hinge, with leather, 10 to 8½ inches long, 4 inches wide, 1 inch lift.
Kind of power used: Steam.
Description of boilers: Two tubular, 16 feet long, 5 feet diameter, 70 pounds pressure; fuel, wood.
Description of engines: Compound condensing, 14 by 24 inches 4 cylinder, slide-valves, rock-shaft; single air-pump; jet condenser; one rotary engine.
Cost of engines and pumps: $33,000.

SAINT LOUIS:
Population: 1,975 inhabitants.
Style of corporation: Municipal.
Water obtained from: Pine river.
Character and dimensions of dam: 600 feet long, running obliquely across Pine river.
Water first introduced: In 1880.
Sizes of distributing mains: 8, 6, and 4 inches.
Total length of distributing mains: 1¼ mile.
Number of water-takers: 69.
First cost of water-works: $7,500.
Average annual cost of maintenance and repairs: $50.
Number of fire-plugs: 23.
Time pumps are run: Steam 2 months, water 10 months per year.
Kind of power used: Steam and water.
Cost of engine and pumps: Steam $2,000, water $500.

MINNESOTA.

MANKATO:
Population: 5,550 inhabitants.
Name of corporation: Mankato Water-Works (municipal).
Water obtained from: Minnesota river.
Total area of water-shed available: About 5,000 square miles.
Water first introduced: September, 1879.
Description of main conduit: 433 feet long, 12 inches diameter; iron.
Sizes of distributing mains: 12, 10, 8, 6, and 4 inches.
Available head: 40 pounds, or 92 feet (average).
Total length of distributing mains: 13,573 feet.
Number of water-takers: 6.

MANKATO—Continued.
First cost of water-works: $16,047 67.
Average annual cost of maintenance and repairs: $2,500.
Number of fire-plugs: 30.
Design and dimensions of pump and water-plungers: One Knowles, made at Warren, Massachusetts; one plain plunger, 1 to 175 strokes per minute; pump-barrel, 12 by 40 inches.
Time pumps are run: Constantly.
Description of force-main: 92 feet long, 12 inches diameter, 40 pounds pressure on pump.
Kind of power used: Steam.
Description of boilers: Pump run by boilers at mill; fuel, wood.
Cost of pump: $1,500.
Remarks: Direct pumping into mains is the only plan available.—Water is drawn below the city and is impregnated with sewage.

MINNEAPOLIS:
Population: 46,887 inhabitants.
Style of corporation: Municipal.
Water obtained from: Mississippi river.
Capacity of reservoir: 19,585 gallons.
Cost of dams: $28,000.
Water first introduced: In 1867.
Sizes of distributing mains: 2 to 16 inches.
Available head: 40 pounds (average).
Total length of distributing mains: 22 miles.
Number of water-takers: 1,600.
Consumption of water: 3,500,000 gallons per day (exact).
First cost of water-works: $150,000.
Average annual cost of maintenance and repairs: $11,000.
Number of fire-plugs: 268.
Design and dimensions of pumps and water-plungers: No. 1, James Waters, built by Charles M. Hardenbury, Minneapolis, Minnesota; double-acting plunger with low piston, 9 inches diameter, 24 inches stroke, 60 strokes per minute; pump-barrel, 9 by 50 inches. Nos. 2 and 3, built by Holly Manufacturing Company, Lockport, New York; double-acting plunger, with low piston, 16 inches diameter, 24 inches stroke, 30 strokes per minute; pump-barrels, 16 by 60 inches.
Time pumps are run: 8,350 hours per year.
Time spent in repairs: 410 hours per year.
Description of force-main: 16 inches diameter.
Description of water-valves: Rubber, 5 by ¾ inches, ¼ inch lift.
Kind of power used: Water.
Description of water-wheels: Two American turbines, 48 inches diameter, 31 feet head, 120 revolutions per minute; 10.75 gallons of water required to lift 1 gallon.

NEW JERSEY.

RAHWAY:
Population: 6,455 inhabitants.
Name of corporation: Rahway Water-Works (municipal).
Water obtained from: North branch of Rahway river.
Total area of water-shed available: About 30 square miles.
Water first introduced: In 1872.
Sizes of distributing mains: 14 to 6 inches.
Available head: 120 feet (average).
Total length of distributing mains: About 5 miles.
Number of water-takers: 700.
Consumption of water: 500,000 gallons per day (average).
First cost of water-works: $135,000.
Average annual cost of maintenance and repairs: $4,500.
Filtering apparatus: Clark filter, 16 feet square; sand, 6 inches deep, on fine wire-cloth; cleaned once in 24 hours.
Number of fire-plugs: 130.
Design and dimensions of pumps and water-plungers: Two duplex Worthington, New York, 1872; plain plungers, 10 and 14 inches diameter, 24 inches stroke, 28 strokes per minute (average), or 7 counter-strokes; pump-barrel, 5 feet by 18 inches.

RAILWAY—Continued.

Time pumps are run: One always in motion, 45 pounds pressure on pumps (average).
Time spent in repairs: 500 hours per year.
Kind of power used: Steam.
Description of boilers: Tubular, 16 feet long, 5 feet diameter, 50 pounds pressure; 10 pounds water to 1 pound coal; fuel, extra good pea coal.
Description of engine: Compound high-pressure cylinder 20 inches diameter, low-pressure cylinder 33 inches diameter, 24 inches stroke; average, 7 counter-strokes per minute; slide-valve worked by opposite piston; 2 air-pumps, single; capacity, $\frac{1}{10}$ of cylinder; jet-condenser, capacity, $\frac{1}{2}$ of cylinder.
Duty of engine: Average 30,000,000 foot-pounds daily.
Remarks: The advantage of pumping direct into mains is that it saves expense of reservoir and long conduits; also fire apparatus.—Water generally good; in spring polluted by refuse of felt factory above, also dead vegetable matter.

NEW YORK.

AUBURN:

Population: 21,924 inhabitants.
Name of corporation: The Auburn Water-Works Company (private).
Water obtained from: Owasco lake.
Total area of water-shed available: 100,000 acres.
Water first introduced: In 1866.
Size of distributing mains: 12 inches.
Available head: 40 pounds (average).
Total length of distributing mains: 23 miles.
Number of water-takers; 1,000.
Consumption of water: 87 gallons per head per day (estimated).
First cost of water-works: $175,000.
Number of fire-plugs: 250.
Design of pumps and water-plungers: Made by Holly Manufacturing Company, Lockport, New York.
Time pumps are run: Constantly.
Description of force-main: 3 miles long, 12 inches diameter.
Kind of power used: Steam and water.
Description of water-wheels: Two American turbines, 64 and 66 inches diameter; head, 16 feet (maximum). One Holly turbine, 66 inches diameter; head, 12 feet (average).
Description of boilers: One tubular upright, 7 feet diameter; one horizontal, 5 feet diameter; 80 pounds pressure.
Description of engines: Four Holly; cylinders, 14 by 24 inches; can be changed to high-pressure or compound at will; Buckley condenser.
Duty of engines: 60,000,000 foot-pounds daily.

BATAVIA:

Population: 4,845 inhabitants.
Style of corporation: Municipal.
Water obtained from: Tonawanda creek.
Total area of water-shed available: 20 square miles.
Character and dimensions of dam: Mill-dam, 99 feet wide, 14 feet high.
Cost of dam: It is owned by Batavia Mills; water supplied at $1,000 per year for ten years.
Water first introduced: In 1874.
Size of distributing mains: 8 inches.
Total length of distributing mains: About 2 miles.
Consumption of water: 4,000 gallons per day (estimated).
First cost of water-works: $30,000.
Average annual cost of maintenance and repairs: $1,300.
Number of fire-plugs: 41.
Time pumps are run: 3 hours per week.
Kind of power used: Steam and water.
Description of water-wheel; Ordinary mill-wheel.

COLLEGE POINT:

Population: 4,192 inhabitants.
Name of corporation: College Point Water-Works (municipal).
Water obtained from: Fresh Meadow springs.

COLLEGE POINT—Continued.

Total area of water-shed available: 9½ square miles.
Capacity of reservoir: 2,500,000 gallons, fed by springs.
Cost of dam: $12,000.
Water first introduced: January, 1875.
Description of main conduit: 40 feet long, 8 feet diameter; brick and planked bottom.
Sizes of distributing mains: 12, 10, 8, and 6 inches.
Available head: 50 pounds, or 133 feet (average).
Total length of distributing mains: 13.8 miles.
Number of water-takers: 410.
Consumption of water: 364,562 gallons per day, or 81 gallons per head (estimated).
First cost of water-works: $212,500.
Average annual cost of maintenance and repairs: $5,000.
Filtering apparatus: 3 graded galvanized-iron screens.
Number of fire-plugs: 56.
Design and dimensions of pump and water-plungers: Built by H. R. Worthington, New York, in 1874; plain plungers, 13 and 14 inches diameter, 24 inches stroke, 9 strokes per minute.
Time pump is run: Constantly.
Time spent in repairs: 2 hours per day per year.
Description of force-main: 24,747 feet long, 12 inches diameter, 50 pounds pressure on pump.
Description of water-valves: Rubber.
Kind of power used: Steam.
Description of boilers: Two tubular flue, 15 feet long, 50 inches diameter, 50 pounds pressure; fuel, Lehigh egg coal.
Description of engine: One compound high-pressure cylinder, 17¼ inches diameter; low-pressure cylinder, 34 inches diameter, 24 inches stroke; one high-pressure, 20 inches diameter, 15 inches stroke; 18 strokes per minute each; ordinary slide-valves, worked by piston-rod; 2 air-pumps, and tank for steam.
Cost of engine and pump: $17,500.
Duty of engine: 37,830,900 foot-pounds daily; 63,927,100 foot-pounds guaranteed.
Remark: A gradual accumulation of fungi matter in hot months.

COOPERSTOWN:

Population: 2,199 inhabitants.
Name of corporation: Cooperstown Aqueduct Association (private).
Water obtained from: Otsego lake.
Total area of water-shed available: About 50 square miles.
Area and capacity of reservoir: 15 square miles, 40 feet deep (average).
Water first introduced: In 1835.
Description of main conduit: 4,300 feet long, 10 inches diameter; cast iron.
Sizes of distributing mains: 8, 6, and 4 inches.
Available head: 45 to 70 feet.
Consumption of water: 60 gallons per head per day (domestic); 100 gallons per minute for fire.
Average annual cost of maintenance and repairs: $400.
Number of fire-plugs: 25.
Design and dimensions of pumps and water-plungers: Two built by H. R. Worthington, New York, in 1880; direct double-acting, 4 cylinders, 8¾ inches diameter, 10½ inches stroke.
Time pumps are run: Constantly.
Description of force-main: 40 to 100 pounds pressure on pumps.
Description of water-valves: Rubber, ⅛ inch lift.
Kind of power used: Water.
Description of water-wheels: Two 50-inch Leffel turbines, double-acting, special, 7 feet head, 80 revolutions per minute.
Cost of engine and pumps: $4,000.

DUNKIRK:

Population: 7,248 inhabitants.
Name of corporation: Dunkirk Water-Works (municipal).

DUNKIRK—Continued.
Water obtained from: Lake Erie.
Water first introduced: July, 1872.
Description of main conduit: 900 feet long, 12 inches diameter; iron, extending into lake with 40 square feet crib at end, made of wood.
Discharging capacity: 2,500,000 gallons.
Sizes of distributing mains: 12 to 3 inches.
Available head: 100 feet (average).
Total length of distributing mains: About 14 miles.
Number of water-takers: 600.
Consumption of water: 1,000,000 gallons per day (estimated).
First cost of water-works: $107,000.
Average annual cost of maintenance and repairs: $6,000.
Number of fire-plugs: 80.
Design and dimensions of pumps and water-plungers: Built by Holly Manufacturing Company, Lockport, New York; 4 plain piston, 9½ inches diameter, 24 inches stroke, 24 strokes per minute; pump-barrel, 9½ by 24 inches; two rotary pumps.
Time pumps are run: Constantly.
Description of main conduit: 14 miles long, 47.64 pounds pressure on pumps.
Description of water-valves: Leather hinge, 10 by 5 inches, ⅜ inch lift.
Kind of power used: Steam.
Description of boilers: Return tubular, 16 feet long, 60 inches diameter; 7 pounds of water to 1 pound coal, 45 pounds pressure; fuel, slack coal.
Description of engine: Non-condensing, 14 by 24 inches, 48 strokes per minute; slide-valve operated by eccentric from shaft.
Cost of pumps and engine: $45,000.
Duty of engine: 55,000,000 foot-pounds daily.

GARDEN CITY:
Population: 574 inhabitants.
Name of corporation: Garden City Water-Works (private).
Water obtained from: Wells.
Total area of water-shed available: About 50 square miles.
Water first introduced: In 1876.
Sizes of distributing mains: 16, 10, 8, 6, and 4 inches.
Available head: About 35 pounds (average).
Total length of distributing mains: 8½ miles.
Number of water-takers: 125.
Consumption of water: 500,000 gallons per day (estimated).
First cost of water-works: $250,000.
Number of fire-plugs: 25.
Design and dimensions of pump and water-plungers: Built by Holly Manufacturing Company, Lockport, New York, in 1876; 4 plain plungers, 7¼ inches in diameter, 22 inches stroke, 20 strokes per minute; pump-barrel, 7¼ by 22 inches.
Time pump is run: Constantly.
Description of water-valves: Solid rubber, 1⅛ inches diameter, ½ inch lift.
Kind of power used: Steam.
Description of boiler: Plain cylinder, 35 pounds pressure; fuel, white-ash coal, grate size.
Description of engine: 20 strokes per minute; slide-valve operated by eccentric; Holly air-pump and condenser.
Cost of engine and pump: About $25,000.

GOUVERNEUR:
Population: 2,071 inhabitants.
Name of corporation: Gouverneur Water-Works (private).
Water obtained from: Oswegatchie river.
Water first introduced: In 1867.
Description of main conduit: Cast iron and cement.
Sizes of distributing mains: 6 and 4 inches.
Available head: 32 pounds (average); water-supply deficient.
Total length of distributing mains: 2 miles.
Number of water-takers: 70.
First cost of water-works: $29,000.

GOUVERNEUR—Continued.
Average annual cost of maintenance and repairs: $500.
Number of fire-plugs: 14.
Design and dimensions of pump and water-plungers: Green rotary, built by Bailey & Sewall, Watertown, New York; 100 to 175 strokes per minute; pump-barrels, 15 and 18 inches diameter.
Time pump is run: Constantly.
Time spent in repairs: 304 hours per year.
Description of force-main: 32 pounds pressure on pump.
Description of water-valves: Slide and tumblers.
Kind of power used: Water.
Description of water-wheels: One Holly and one Weaver turbine; 7 to 9 revolutions per minute.
Remarks: The disadvantage of pumping direct into mains is that when pressure is used for fire purposes it is felt by all dwellings.

JORDAN:
Population: 1,344 inhabitants.
Name of corporation: S. L. Rockwell & Co. (private).
Water obtained from: Skaneateles outlet.
Water first introduced: In 1880.
Description of main conduit: 2,300 feet long, 3½ inches diameter; wrought iron.
Size of distributing mains: 3½ inches.
Total length of distributing mains: 2,300 feet.
First cost of water-works: $2,000.
Number of fire-plugs: 4.
Design and dimensions of pump and water-plunger: Built by S. Button & Son, Waterford, New York, in 1880; one plain plunger, 6 inches diameter, 6 inches stroke, 200 strokes per minute; pump-barrel, 6 by 6 inches.
Description of water-valves: Plain brass.
Kind of power used: Water.
Description of water-wheels: One Bodine-Jonval turbine, 40 inches diameter, 10 feet head, 114 revolutions per inute.
Remark: Water used only for fire purposes.

LOCKPORT:
Population: 13,522 inhabitants.
Name of corporation: No specific name; the Holly Manufacturing Company owns the machinery and the city owns the pipes.
Water obtained from: Erie canal.
Water first introduced: In 1869.
Sizes of distributing mains: 12, 10, 8, 6, and 4 inches.
Available head: 230 feet on pumps, 150 feet on distribution (average).
Total length of distributing mains: About 7 miles.
Number of water-takers: 430.
Consumption of water: 80 gallons per head (estimated).
Average annual cost of maintenance and repairs: About $2,000.
Number of fire-plugs: 110.
Design and dimensions of pump and water-plungers: Built by Holly Manufacturing Company, Lockport, New York, in 1871; 4 plain plungers, 9 inches diameter, 20 to 50 strokes per minute; pump-barrel, 9 by 24 inches.
Time pump is run: Constantly.
Description of force-main: 12 inches diameter, 100 to 140 pounds pressure on pump.
Description of water-valves: Plain hinge-valves, faced with leather.
Kind of power used: Water.
Description of water-wheels: American turbine, 42 inches diameter, made by Stout, Mills & Temple, Dayton, Ohio; 56 feet head; revolutions, according to consumption.
Cost of engine and pump: $10,000.
Remark: The advantage of pumping direct into mains consists in this, that the head can be varied to meet demand.—Water is unfit for domestic use, owing to impurities resulting from sewerage.

LONG ISLAND CITY:
Population: 17,129 inhabitants.
Name of corporation: Long Island City Water Company (municipal).
Water obtained from: Driven wells.
Water first introduced: In 1875.
Description of main conduit: 16 inches diameter; cast iron.
Sizes of distributing mains: 16, 12, 10, 8, and 6 inches.
Available head: 25 pounds (average); water-supply deficient.
Total length of distributing mains: 16 miles.
Number of water-takers: 861.
Consumption of water: About 1,200,000 gallons per day (estimated).
First cost of water-works: $350,000.
Average annual cost of maintenance and repairs: $19,000.
Design of pumps and water-plungers: Built by Holly Manufacturing Company, Lockport, New York, and by Guild & Garison, Brooklyn, New York.
Time pumps are run: Constantly.
Kind of power used: Steam.
Remarks: The advantage of pumping direct into mains is that the force can be increased to meet the wants of extingnishing fires without steam or hand fire-engines.

NIAGARA FALLS:
Population: 3,320 inhabitants.
Name of corporation: Niagara Falls Water-Works Company (private).
Water obtained from: Niagara river.
Cost of dam: Water-works to point of distribution owned by Suspension Bridge Water-Works Company.
Water first introduced: July, 1877.
Sizes of distributing mains: 10 to 4 inches.
Available head: 70 pounds (average).
Total length of distributing mains: 5 miles.
Consumption of water: 1,500,000 gallons per day (estimated).
First cost of water-works: $30,000.
Average annual cost of maintenance and repairs: $100.
Number of fire-plugs: 31.
Kind of power used: Water.
Remarks: The advantage of pumping direct into mains is economy; the disadvantage, that supply ceases when pumps stop for repairs.

OGDENSBURG:
Population: 10,341 inhabitants.
Name of corporation: Ogdensburg Water-Works (municipal).
Water obtained from: Oswegatchie river.
Water first introduced: November, 1868.
Sizes of distributing mains: 12, 10, 8, 6, 4, and 3 inches.
Available head: 40 pounds (average).
Total length of distributing mains: 14 miles.
Number of water-takers: 1,100.
Consumption of water: 1,000,000 gallons per day (exact).
First cost of water-works: $150,000.
Average annual cost of maintenance and repairs: Extension, $6,430; materials, $176 62.
Number of fire-plugs: 82.
Design and dimensions of pumps and water-plungers: One Lang, built at Burlington, Vermont; one Flanders, built at Vergennes, Vermont; two plain plungers to each pump; one 14 inches diameter, 30 inches stroke; one 14 inches diameter, 20 inches stroke; 28 strokes per minute; pump-barrel, 14 inches diameter; total capacity, 5,000,000 gallons.
Time pumps are run: Constantly.
Description of force-main: 40 pounds pressure on pumps.
Description of water-valves: Rubber disks; Lang, 14 inches diameter; Flanders, 9 inches diameter; 1 inch lift (average).
Kind of power used: Steam and water.
Description of water-wheels: Two Holly turbines, 72 inches diameter; one Gates-Curtis turbine, 56 inches diameter; 4 to 13 feet head (fluctuating); 40 to 75 revolutions per minute.
Description of boilers: Marine return-flue; fuel, bituminous coal.

OGDENSBURG—Continued.
Description of engine: Non-condensing, 16 inches diameter, 36 inches stroke, 45 strokes per minute; slide-valves operated by eccentric on crank-shaft, with graduating cut on main-valve driven by eccentric.
Cost of engine and pumps: $16,200.
Remarks: The advantage of pumping direct into mains is that but 40 pounds pressure are maintained under ordinary circumstances.

OLEAN:
Population: 3,036 inhabitants.
Name of corporation: Olean Water-Works (municipal).
Water obtained from: Olean creek.
Water first introduced: In 1877.
Sizes of distributing mains: 6 and 4 inches.
Total length of distributing mains: 3 miles.
Consumption of water: 100,000 gallons per day.
Average annual cost of maintenance and repairs: $1,500.
Design and dimensions of pump and water-plunger: Built by W. H. Kelly, New Brunswick, New Jersey; plain plunger, 6 inches diameter, 75 strokes per minute; pump-barrel, 6 inches diameter.
Time pump is run: Constantly.
Description of force-main: 50 pounds pressure on pump.
Description of water-valves: Metallic; seats, rubber.
Kind of power used: Steam.
Description of boilers: Two, 11 feet long, 40 inches diameter; fuel, soft coal.
Description of engine: Simple; cylinder, 12 inches diameter, 150 strokes per minute.
Cost of engine and pump: $1,500.

POTSDAM:
Population: 2,762 inhabitants.
Style of corporation: Municipal.
Water obtained from: Rocket river.
Character and dimensions of dams: Two, wooden; 100 feet long each.
Water first introduced: In 1871.
Sizes of distributing mains: 8, 6, and 4 inches.
Available head: 78 feet (average).
Total length of distributing mains: About 2 miles.
Number of water-takers: 198.
Consumption of water: 30 gallons per head per day (estimated).
First cost of water-works: $50,000.
Average annual cost of maintenance and repairs: $325.
Filtering apparatus: Wooden well, about 20 feet square; small stone and gravel; cleaned three times a year.
Number of fire-plugs: 33.
Design and dimensions of pump and water-plunger: Built by Holly Manufacturing Company, Lockport, New York, in 1871; size No. 6; 30 revolutions per minute; pump-barrel, 12 by 14 inches; head, 78 feet (average) on pump.
Time pump is run: Constantly.
Time spent in repairs: About 200 hours per year.
Description of water-valves: Flap; size, 9 inches; lift, 90°.
Kind of power used: Water.
Description of water-wheels: One Holly turbine, 7 feet diameter, drawing 1,300 inches water; one American turbine, 48 inches diameter, drawing 336 inches water; about 9 feet head.
Cost of engines and pump: $10,000.

SARATOGA SPRINGS:
Population: 8,421 inhabitants.
Style of corporation: Municipal.
Water obtained from: Creek and springs.
Area and capacity of reservoir: Lake, 108 acres; average depth, 18 feet.
Cost of dam: About $26,000.
Water first introduced: July, 1871.
Description of main conduit: 580 feet long, 3 feet diameter, brick; 300 feet long, wood; head, 8 feet.
Sizes of distributing mains: 12 to 3 inches.
Available head: 62 to 172 feet; water-supply deficient.

SARATOGA SPRINGS—Continued.
Total length of distributing mains: 17 93/100 miles.
Number of water-takers: 1,346.
Consumption of water: 117 gallons per head per day (exact).
First cost of water-works: $250,000.
Average annual cost of maintenance and repairs: $7,358 07.
Number of fire-plugs: 133.
Design and dimensions of pump and water-plunger: Built by Holly Manufacturing Company, Lockport, New York, in 1870–'71; plain piston-plunger; square rubber packing; 8 to 20 strokes per minute; pump-barrel, 10 by 24 inches.
Time pump is run: Constantly.
Description of force-main: 2,678 feet long, 12 inches diameter, 172 to 184 feet head on pump.
Description of water-valves: Leather hinge, iron shod; 9 by 3½ inches size, 1¼ inch lift.
Kind of power used: Steam and water.
Description of water-wheels: Two Leffel turbines, 36 and 6 inches diameter, 30 feet head.
Description of boilers: One double return-flue, one marine and one upright flue; fuel, Scranton grate coal.
Description of engine: Condensing or high-pressure, at will, 14 inches diameter, 24 inches stroke, 20 to 50 strokes per minute; balanced lift-valve, worked by cams, governed by water in pipes; 2 air-pumps, 10 inches diameter, 14 inches stroke; jet-condenser.
Cost of engine and pump: $46,000.
Duty of engine: 48,000,000 to 50,000,000 foot-pounds daily.
Remark: The advantage of pumping direct into mains is economy.—In hot weather a green vegetable growth pollutes the water.

SCHENECTADY:
Population: 13,655 inhabitants.
Name of corporation: Schenectady Water Company (private).
Water obtained from: Mohawk river.
Character and dimensions of dam: 20 feet from river, 114 feet long, 10 feet wide, 18 feet deep, arched with brick to keep out surface-water.
Water first introduced: September, 1872.
Description of main conduit: 11 miles long, 12, 10, 8, 6, and 4 inches diameter; head, 140 feet (average).
Sizes of distributing mains: 12, 10, 8, 6, and 4 inches.
Available head: 60 to 80 pounds.
Total length of distributing mains: 11 miles.
Number of water-takers: 411.
Consumption of water: 60 gallons per head per day (estimated).
First cost of water-works: $115,000.
Average annual cost of maintenance and repairs: $7,000.
Filtering apparatus: Well, 114 by 6 feet; coarse sand and gravel.
Number of fire-plugs: 123.
Design and dimensions of pumps and water-plungers: Six, built by Holly Manufacturing Company, Lockport, New York; 12 inches diameter, 12 inches stroke, 12 to 20 strokes per minute; pump-barrel, 12 by 12 inches.
Time pumps are run: Constantly.
Description of force-main: 11 miles long, 75 pounds pressure on pumps.
Description of water-valves: Brass; 7 by 4 inches size, 2½ inches lift.
Kind of power used: Steam.
Description of boilers: One upright flue, one locomotive, 150 horse-power each; fuel, anthracite coal.
Description of engine: Condensing or non-condensing; 16 by 24 inches, 15 to 25 strokes per minute; plain D-valves, automatic cut-off.
Cost of engine and pumps: $30,000.

OHIO.

DAYTON:
Population: 38,678 inhabitants.
Name of corporation: Dayton City Water-Works (municipal).

DAYTON—Continued.
Water obtained from: Wells.
Water first introduced: In 1870.
Sizes of distributing mains: 20, 16, 12, 10, 8, 6, 4, 3, and 2 inches.
Total length of distributing mains: 32 81/320 miles.
Consumption of water: About 1,000,000 gallons per day (estimated).
First cost of water-works: $555,000.
Average annual cost of maintenance and repairs: $16,000.
Filtering system: A tunnel 300 feet long, 26 feet below surface of ground.
Number of fire-plugs: 281.
Design and dimensions of pumps and water-plungers: Made by Holly, in 1870; pump-barrels, 12 by 27 inches.
Description of force-main: 4,416 feet long, 20 inches diameter, and 100 feet long, 12 inches diameter; 50 pounds pressure on pumps.
Kind of power used: Steam.

IRONTON:
Population: 8,857 inhabitants.
Name of corporation: City Water-Works (municipal).
Water obtained from: Ohio river.
Water first introduced: July, 1873.
Sizes of distributing mains: 12 to 4 inches.
Available head: 30 pounds (average).
Total length of distributing mains: About 8 miles.
Number of water-takers: 850.
Consumption of water: 650,000 gallons per day (estimated).
First cost of water-works: $175,000.
Number of fire-plugs: 114.
Design and dimensions of pump and water-plungers: Six bucket-plungers, 14 inches diameter, 14 inches stroke, 10 strokes per minute; pump-barrels, 14 inches diameter.
Time pump is run: Constantly.
Description of water-valves: Rubber, 12 inches, 1 inch lift.
Kind of power used: Steam.
Description of boilers: Tubular, 15 feet long, 5 feet diameter; fuel, bituminous coal.
Description of engines: Two non-condensing, 14 inches diameter, 24 inches stroke, 30 strokes per minute; slide-valve with cut-off.
Cost of engines and pump: $35,000.
Duty of engines: 2,000,000 gallons in 24 hours guaranteed.
Remarks: The disadvantage of pumping direct into main is muddy water sometimes; the river brings down leaves and drift-wood, which are an annoyance in pumping.

MANSFIELD:
Population: 9,859 inhabitants.
Name of corporation: Mansfield Water-Works (municipal).
Water obtained from: Springs.
Water first introduced: August, 1872.
Sizes of distributing mains: 14, 12, 8, 6, 5, and 4 inches.
Available head: 80 pounds (average).
Total length of distributing mains: 15 miles.
Number of water-takers: 550.
Consumption of water: 500,000 gallons per day (estimated).
First cost of water-works: $175,000.
Average annual cost of maintenance and repairs: $7,500.
Number of fire-plugs: 100.
Design and dimensions of pump and water-plungers: Built by Holly Manufacturing Company, Lockport, New York, in 1872.
Time pump is run: Constantly.
Description of force-main: 2,868 feet long, 14 inches diameter, 80 pounds pressure on pump.
Description of water-valves: Leather, 4 by 11 inches, 1¼ inch lift.
Kind of power used: Steam.
Description of boilers: Three; 12 feet long, 60 inches diameter, 60 pounds pressure; fuel, slack coal; one boiler used at a time.

MANSFIELD—Continued.

Description of engine: Condensing and non-condensing; 2 cylinders, 14 inches diameter, 24 inches stroke, 24 strokes per minute; slide-valve, puppet cut-off.
Cost of engine and pump: $32,000.
Remarks: The advantage of pumping direct into mains is great pressure for fire purposes.

NORWALK:

Population: 5,704 inhabitants.
Name of corporation: Norwalk Water-Works (municipal).
Water obtained from: Huron river.
Character and dimensions of dam: Stone, 55 feet long; bottom 13 feet wide, top 2 feet 6 inches wide; laid in Portland cement; top stones clapped with 1½ inch square iron.
Cost of dam: $3,400.
Water first introduced: In 1870.
Description of main conduit: 3½ miles long; diameters, 10, 8, 6, 4, and 3 inches; cast iron; 75 pounds pressure (average).
Sizes of distributing mains: 10 to 3 inches.
Available head: 70 pounds (average).
Total length of distributing mains: 11 miles.
Number of water-takers: 360.
Consumption of water: 400,000 gallons per day (estimated).
First cost of water-works: $100,000.
Average annual cost of maintenance and repairs: $4,800.
Number of fire-plugs: 94.
Design and dimensions of pump and water-plungers: Built by Worthington, New York; four plain plungers, 25 by 14 inches and 15 by 12 inches; 28 strokes per minute; pump-barrel, 62 inches long, 14 inches diameter.
Time pump is run: Constantly.
Description of force-main: 200 feet long, 173 pounds pressure on pump.
Description of water-valves: Rubber, 6 inches diameter, 1¼ inch lift.
Kind of power used: Steam.
Description of boilers: Holly, 16 feet long, 5 feet diameter, 44 pounds pressure; fuel, Massillon coal.
Description of engines: Condensing, compound, double; low-pressure cylinder, 33⅜ inches diameter, high-pressure cylinder, 19¼ inches diameter; 25 inches stroke each, 28 strokes per minute; slide-valves; Worthington air-pumps and condenser.
Cost of pump and engines: $13,000.
Duty of engines: 41,186,345 foot-pounds daily.
Remarks: The disadvantage of pumping direct into mains is non-uniformity of pressure.—Impurities are caused by rain washing banks of river, making water muddy.

PORTSMOUTH:

Population: 11,321 inhabitants.
Name of corporation: City Water-Works (municipal).
Water obtained from: Ohio river.
Water first introduced: In 1871.
Discharging capacity of conduit: 650 gallons per minute.
Sizes of distributing mains: 12, 10, 8, 6, and 4 inches.
Available head: 40 pounds (average).
Design and dimensions of pumps and water-plungers: Built by Holly Manufacturing Company, Lockport, New York, in 1871; six plain plungers, 14 inches diameter, 24 inches stroke, 12 strokes per minute; pump-barrel, 14 by 24 inches.
Time pumps are run: Constantly.
Description of force-main: 40 pounds pressure on pumps.
Description of water-valves: Leather, 2½ by 5 inches in size, 2 inches lift.
Kind of power used: Steam.
Description of boilers: 18 feet long, 60 inches diameter; 67 tubes, 3¼ inches diameter; fuel, soft Ohio River coal.
Description of engines: Non-condensing; two cylinders, 14 inches diameter, 24 inches stroke; one rotary engine, 20 inches diameter, 15 inches stroke; piston-head; two pumps for fire, 20 by 8 inches, 25 strokes per minute; slide-valves worked by eccentric, with balance cut-off.

SIDNEY:

Population: 3,823 inhabitants.
Style of corporation: Municipal.
Water obtained from: Mosquito creek.
Water first introduced: October, 1873.
Sizes of distributing mains: 12, 9, and 6 inches.
Available head: 175 pounds (average).
Total length of distributing mains: 3 miles.
Number of water-takers: 100.
First cost of water-works: $56,000.
Average annual cost of maintenance and repairs: $1,400.
Number of fire-plugs: 38.
Design of pump and water-plunger: Built by the Holly Manufacturing Company, Lockport, New York.
Time pump is run: 18 hours per day.
Time spent in repairs: 1 week per year.
Kind of power used: Water.
Description of water-wheels: Two; Holly patent, 20 feet fall.
Remarks: The disadvantage of pumping direct into mains is that the pressure on the pipes is too uneven.—Water is muddy after rains.

URBANA:

Population: 6,252 inhabitants.
Name of corporation: Urbana Water-Works Company (private).
Water obtained from: Well.
Area and capacity of reservoir: Well, 20 feet diameter, 20 feet deep.
Water first introduced: February, 1878.
Sizes of distributing mains: 14 to 4 inches.
Available head: 125 feet (average).
Total length of distributing mains: 9 miles.
Number of water-takers: 253.
Consumption of water: 260,000 gallons per day (estimated).
Average annual cost of maintenance and repairs: $2 90.
Number of fire-plugs: 73.
Design and dimensions of pump and water-plungers: Built by Holly Manufacturing Company, Lockport, New York, in 1877; piston-plungers, 7½ inches diameter, 2 feet stroke, 24 strokes per minute; pump-barrel, 7½ inches diameter.
Time pump is run: Constantly.
Time spent in repairs: None.
Description of force-main: 9 miles long, 45 pounds pressure on pump.
Description of water-valves: Brass hinge, 8 by 4 inches, ⅛ inch lift.
Kind of power used: Steam.
Description of boilers: Return-flue, 16 feet long, 5 feet diameter, 50 pounds pressure; 14¼ pounds water to 1 pound coal; fuel, bituminous coal.
Description of engine: Compound condensing, 12 inches diameter, 2 feet stroke; 4 cylinders; 24 strokes per minute; slide-valve operated by eccentric; air-pump piston, with rubber valve; jet-condenser.
Cost of pump and engine: $20,000.
Duty of engine: 30,080,555 foot-pounds; 900 pounds coal to 8,260,000 gallons daily.

YOUNGSTOWN:

Population: 15,435 inhabitants.
Name of corporation: City Water-Works (municipal).
Water obtained from: Mahoning river.
Water first introduced: In 1871.
Sizes of distributing mains: 15, 12, 8, 6, and 4 inches.
Available head: 70 to 80 pounds.
Total length of distributing mains: 11 miles.
Number of water-takers: 840.
Consumption of water: 1,500,000 gallons per day (estimated).
First cost of water-works: $150,000.
Average annual cost of maintenance and repairs: $7,500
Number of fire-plugs: 105.

YOUNGSTOWN—Continued.
Design and dimensions of pump and water-plunger: Built by H. R. Worthington, New York; pump-barrel, 17½ by 36 inches.
Time pump is run: Constantly.
Kind of power used: Steam.
Description of boilers: Three tubular; one 16 feet long, 6 feet diameter; two small upright drop-tubes; fuel, bituminous coal.
Description of engine: Non-expanding condensing; Worthington valves; air-pump and condenser.
Cost of engine and pump: $10,000.

OREGON.

ALBANY:
Population: 1,867 inhabitants.
Name of corporation: Crawford & Foster (private).
Water obtained from: Santian canal and Calapoosa river.
Water first introduced: July, 1880.
Sizes of distributing mains: 6, 4, 3, and 2 inches.
Available head: 100 feet (average).
Total length of distributing mains: About 3 miles.
First cost of water-works: About $20,000.
Number of fire-plugs: 2.
Design and dimensions of pumps and water-plungers: Built by S. H. Moore, Portland, Oregon; two pumps, 24 by 12 inches, 12 to 24 strokes per minute; pump-barrel, 12 by 24 inches.
Time pumps are run: Constantly.
Description of force-mains: A tank 75 feet high; 45 pounds pressure on pumps.
Kind of power used: Water.
Description of water-wheels: One Burnham and one Leffel; 24 feet head.

PENNSYLVANIA.

DANVILLE:
Population: 8,346 inhabitants.
Name of corporation: Danville Water-Works (municipal).
Water obtained from: Well on river-bank.
Area and capacity of reservoir: 50 feet long, 7½ feet wide, 10 feet deep.
Cost of dam: $4,000.
Water first introduced: In 1872.
Sizes of distributing mains: 12, 8, 6, and 4 inches.
Available head: 65 pounds (average).
Number of water-takers: 800.
First cost of water-works: $125,000.
Average annual cost of maintenance and repairs: $4,000.
Filtering system: Gravel and sand.
Number of fire-plugs: 97.
Design and dimensions of pumps and water-plungers: Built by the Holly Manufacturing Company, Lockport, New York; six plain plungers 14 inches diameter, and six 18 inches diameter two rotary, capacity 316,800 gallons, 10 strokes per minute.
Kind of power used: Steam.
Description of boilers: One horizontal, 18 feet long, 5 feet diameter; one upright, 20 feet high, 7 feet diameter.
Description of engines: One double, 150 horse-power; one rotary, 200 horse-power.
Cost of engines and pumps: $36,000.
Remarks: The advantage of pumping direct into mains is marked control of pressure.

TITUSVILLE:
Population: 9,046 inhabitants.
Name of corporation: City Water-Works (municipal).
Water obtained from: Dug well.
Water first introduced: January, 1873.
Sizes of distributing mains: 15, 12, 8, 6, 4, and 2 inches.
Available head: 40 pounds (average).
Total length of distributing mains: 9½ miles.

TITUSVILLE—Continued.
Number of water-takers: 720.
Consumption of water: 400,000 gallons per day (estimated).
First cost of water-works: $139,000.
Average annual cost of maintenance and repairs: $7,000.
Number of fire-plugs: 63.
Design and dimensions of pump and water-plunger: Holly; 20 strokes per minute.
Time pump is run: Constantly.
Kind of power used: Steam.
Description of boilers: Two 40 horse-power flue; fuel, slack and nut bituminous coal.
Cost of engine and pump: $30,000.

VIRGINIA.

NORFOLK:
Population: 21,966 inhabitants.
Name of corporation: City Water-Works (municipal).
Water obtained from: Springs and lake Lawson.
Total area of water-shed available: 500 acres.
Capacity of reservoirs: One lake, 470,000,000 gallons; Lawson, 120,000,000 gallons; Morris, 40,000,000 gallons.
Character and dimensions of dams: All puddled clay.
Cost of dams: $500,000.
Water first introduced: In July, 1873.
Description of main conduit: 4.6 miles long, 12 inches diameter; cast iron.
Discharging capacity: 900,000 gallons per day, 40 pounds pressure (average).
Description of settling reservoirs: Two; one, capacity 5,000,000 gallons, and one, capacity 3,000,000 gallons; water is pumped into these from lake Lawson and thence into mains.
Sizes of distributing mains: 10, 8, 6, 4, 3, and 2 inches.
Available head: 40 pounds (average).
Total length of distributing mains: 22 miles.
Consumption of water: 70 gallons per head (estimated).
Number of water-takers: 2,100.
First cost of water-works: $450,000.
Average annual cost of maintenance and repairs: $12,000 to $13,000.
Filtering system: Use settling reservoirs.
Number of fire-plugs: 95.
Design and dimensions of pumps and water-plungers: One set Holly and two Worthington; plain plungers; two 14 inches diameter, 24 inches stroke; two 14 inches diameter, 26 inches stroke.
Time pumps are run: Constantly.
Description of force-main: 4.6 miles long, 12 inches diameter, 45 pounds pressure on pumps.
Description of water-valves: Rubber disks, 6 inches diameter, ¾ inch lift.
Kind of power used: Steam.
Description of boilers: Two; fuel, Georgia Creek coal.
Description of engines: One Worthington compound and one high-pressure, 44 strokes per minute; slide-valves operated by connecting-rod and rock-shaft; one set Holly pumps.
Cost of engines and pumps: $50,000.
Remarks: The advantage of pumping direct into mains is the perfect control of pressure for fire service.

WEST VIRGINIA.

MARTINSBURG:
Population: 6,335 inhabitants.
Style of corporation: Municipal.
Water obtained from: Springs.
Water first introduced: In 1873.
Sizes of distributing mains: 12 to 1½ inches.
Available head: 30 pounds (average).
Total length of distributing mains: About 6 miles.
Number of water-takers: 480.
Consumption of water: 200,000 gallons per day (estimated).
First cost of water-works: About $80,000.

MARTINSBURG—Continued.

Average annual cost of maintenance and repairs: $1,200.
Number of fire-plugs: 42.
Design and dimensions of pumps and water-plungers: Built by the Holly Manufacturing Company, Lockport, New York; four double-acting piston, 7½ inches bore, 22 inches stroke.
Time pumps are run: Constantly.
Description of force-main: 4½ miles long, 60 pounds pressure on pumps.
Description of water-valves: Leather, 3 by 6 inches.
Kind of power used: Steam and water.
Description of water-valves: Two American turbine; one 30 inches and one 54 inches diameter; made by Stout, Mills, & Temple, Dayton, Ohio; 10 feet head.
Description of boiler: Horizontal, 16 feet long, 60 inches diameter; 54 tubes, 3½ inches diameter.
Description of engine: Condensing or non-condensing, 16 by 27 inches; puppet-valve, operated by cams; plain air-pump, 14 by 24 inches.
Cost of engine and pumps: $20,000.

WISCONSIN.

BLACK RIVER FALLS:

Population: 1,427 inhabitants.
Style of corporation: Municipal.
Water obtained from: Black river.
Character and dimensions of dam: One across Black river, at head of falls, made of brush and stone; head obtained, 11 feet.
Water first introduced: In 1875.
Size of distributing mains: 6 inches.
First cost of water-works: About $6,000.
Average annual cost of maintenance and repairs: $125.
Number of fire-plugs: 6.

749

BLACK RIVER FALLS—Continued.

Design and dimensions of pump and water-plunger: Rotary, Johnson's patent, built by B. F. Babbitt, Utica, New York; 350 revolutions per minute; pump-barrel, 12 inches diameter.
Description of force-main: 100 feet long, 6 inches diameter; head, 12 feet on pump.
Kind of power used: Water.
Description of water-wheels: Two turbines, 60 inches diameter, Houston patent, Racine, Wisconsin, 11 feet head, 115 revolutions per minute.

LA CROSSE:

Population: 14,505 inhabitants.
Style of corporation: Municipal.
Water obtained from: Mississippi river.
Water first introduced: In 1877.
Sizes of distributing mains: 16, 12, 8, and 6 inches.
Available head: 40 pounds (average).
Total length of distributing mains: 8½ miles.
Number of water-takers: 325.
First cost of water-works: $90,000.
Number of fire-plugs: 90.
Design and dimensions of pumps and water-plungers: Duplex, built by G. F. Blake Manufacturing Company, Boston, Massachusetts, 30 inches steam, 16 inches water, 2 feet stroke each; pump-barrel, 16 inches diameter.
Time pumps are run: Constantly.
Kind of power used: Steam.
Description of boilers: Two; 16 feet long, 5 feet diameter; fuel, pine slabs.
Description of engine: Simple, high-pressure; cylinder, 30 inches diameter, 24 inches stroke.
Cost of engine and pumps: $10,000.
Remarks: The advantage of pumping direct into mains is cheapness; the disadvantage, non-uniformity of pressure.

WATER-WORKS EMPLOYING THE GRAVITY SYSTEM AND PUMPING TO DISTRIBUTING RESERVOIR.

CALIFORNIA.

SAN FRANCISCO:

Population: 233,959 inhabitants.
Name of corporation: Spring Valley Water-Works (private).
Total area of water-shed available: 28 square miles.
Capacity of receiving reservoirs: Pilarcitos, 140,000,000 cubic feet; San Andres, 1,930,000,000 cubic feet; Crystal Springs, 1,200,000,000 cubic feet.
Character and dimensions of dams: Pilarcitos, 95 feet high, 600 feet long, 25 wide on top; water-slope, 2½ to 1; dry-slope, 3 to 1. San Andres, 95 feet high, 640 long, 25 feet wide on top; water-slope, 3½ to 1; dry-slope, 3 to 1. Crystal Springs, 80 feet high, 500 feet long, 30 feet wide on top; water-slope, 3½ to 1; dry-slope, 3 to 1.
Water first introduced: In 1858.
Description of main conduits: Pilarcitos, 7,840 feet long, 3 feet 6 inches by 4 feet 6 inches cross-section, oval, brick masonry; also 16 miles long, 30 inches diameter, tarred wrought iron. San Andres, 3,050 feet long; 3 feet 6 inches by 4 feet 6 inches cross-section, oval, brick masonry; also 12 miles long, 30 inches diameter, tarred wrought iron. Labos creek, 3,000 feet long, 3½ by 4 feet cross-section, brick; also 8,900 feet long, 24 inches diameter, cement pipe; also 2 miles redwood flue, 22 inches to 19 inches.
Discharging capacity: Pilarcitos, 11,000,000 gallons per day; head, 375 feet (average). San Andres, 9,500,000 gallons per day; head, 250 feet (average). Labos creek, 2,000,000 gallons per day; head, 290 feet (average).
Description of distributing reservoirs: Lake Hunda, heavy masonry work; capacity, 35,000,000 gallons; elevation, 377 feet. College Hill, capacity, 14,000,000 gallons; elevation, 252 feet. Market street, capacity, 2,250,000 gallons; elevation, 200 feet. Upper Russian Hill, capacity, 4,500,000 gallons; elevation, 295 feet. Lower Russian Hill, capacity, 6,000,000 gallons; elevation, 148 feet. Clay Street Hill tank, capacity, 140,000 gallons; elevation, 365 feet.
Sizes of distributing mains: 22 to 3 inches.
Available head: 50 to 100 pounds.
Total length of distributing mains: 175 miles.
Number of water-takers: 20,500.
Consumption of water: 62.5 gallons per head per day (estimated).
Number of fire-plugs: 1,350.
Design and dimensions of pumps and water-plungers: Built by Pacific Iron Works and Vulcan Iron Works, San Francisco, in 1858 and 1862; Risdon Iron Works, San Francisco, in 1877; plain plungers, 6 to 18 strokes per minute; pump-barrels, L. C. 2 P., 14 inches diameter, 7 feet stroke; C. S. 2 P., 12 inches diameter, 5 feet stroke; L. M. 2 P., 20 inches diameter, 6 feet stroke.
Time pumps are run: Lobos Creek, constantly; balance stopped.
Time spent in repairs: 1 day per year.
Description of force-mains: Lobos Creek, 60 pounds pressure on pumps; on two, 150 pounds pressure; Crystal Spring, 190 pounds pressure; L. M., 130 pounds pressure.

SAN FRANCISCO—Continued.

Description of water-valves: Crystal Spring and L. M., double-beat crown.
Kind of power used: Steam.
Description of boilers: Lobos Creek, 4 tubular, 16 feet long, 42 inches diameter; tubes, 3 inches diameter; evaporation, Mount Diablo coal, 5 to 1, and for anthracite, 10¼ to 1.
Description of engines: Lobos Creek, condensing; cylinder, 40 inches diameter, 48 inches stroke; Crystal Spring, distinct acting compound condensing; L. M., direct compound condensing, 30 strokes per minute; Lobos Creek, ordinary lift-valve with screw; air-pump, 30 by 24 inches; jet-condenser, 24 by 36 inches.
Duty of engines: Lobos Creek, with anthracite coal, 50,000,000 foot-pounds daily; with Mount Diablo coal, 4,000,000 foot-pounds daily.

VALLEJO:

Population: 5,987 inhabitants.
Name of corporation: Vallejo City Water Company (private).
Water obtained from: Surface-water.
Total area of water-shed available: About 100 square miles.
Capacity of reservoir: 500,000,000 gallons.
Character and dimensions of dam: 35 feet long, 40 feet high 150 feet base; built in sections; dirt and clay; best material in front section; stone rubbish and coarse material in back section.
Cost of dam: $40,000.
Water first introduced: In 1871.
Description of main conduit: 3½ miles long, 12 inches diameter; cast iron.
Description of distributing reservoir: Situated at an elevation of 150 feet above tide-water.
Sizes of distributing mains: 12, 6, 4, and 2 inches.
Total length of distributing mains: About 18 miles.
Number of water-takers: About 1,000.
Consumption of water: 100,000 gallons per day (estimated).
First cost of water-works: $200,000.
Number of fire-plugs: 35.
Design and dimensions of pump and water-plunger: Hooker, built by W. F. Garrett, San Francisco; plain No. 8 plunger, 16 inches stroke, 100 strokes per minute; pump-barrel, 6 by 18 inches.
Time pump is run: 12 hours per day in summer and 6 hours per day in winter.
Description of force-main: 3½ miles long.
Description of water-valves: Rubber, 6 inches diameter.
Kind of power used: Steam.
Description of boiler: 60 horse-power, 40 pounds pressure.
Cost of pump: $700.

COLORADO.

LEADVILLE:

Population: 14,820 inhabitants.
Name of corporation: Leadville Water Company (private).
Water obtained from: Stream in Big Evans gulch.
Total area of water-shed available: About 6 square miles.
Dimensions of dam: 200 by 300 feet, 12 feet deep (average).

LEADVILLE—Continued.
Cost of dam: $100,000.
Water first introduced: March, 1879.
Description of main conduit: 75,639 feet long, 6 and 8 inches diameter; cast iron.
Discharging capacity: About 16,000 gallons per hour; head, 190 feet (average).
Description of distributing reservoir: 40 by 20 feet, 16 feet deep; it is covered; capacity, 96,000 gallons.
Sizes of distributing mains: 8, 6, and 4 inches.
Available head: 165 feet (average).
Total length of distributing mains: 4¼ miles.
Number of water-takers: About 300.
Consumption of water: 100,000 gallons per day (estimated).
First cost of water-works: $77,000.
Average annual cost of maintenance and repairs: $12,000.
Number of fire-plugs: 47.
Design of pumps and water-plungers: Knowles' patent.

ILLINOIS.

OREGON:
Population: 1,088 inhabitants.
Style of corporation: Municipal.
Water obtained from: Rock river.
Capacity of reservoir: Over 1,000,000 gallons.
Character and dimensions of dam: Across Rock river; made for running mills, etc.
Cost of dam: Dam, $75,000; reservoir, $14,000.
Water first introduced: November, 1879.
Description of main conduit: 35,000 feet long, 8 inches diameter; iron.
Discharging capacity: 31,500 gallons per hour; head, 200 feet (average).
Description of distributing reservoir: Circular; diameter, 150 feet, 13 feet deep.
Sizes of distributing mains: 8 and 6 inches.
Available head: 200 feet (average).
Total length of distributing mains: 1½ mile.
Number of water-takers: 45.
First cost of water-works: $14,000.
Average annual cost of maintenance and repairs: $200.
Number of fire-plugs: 13.
Design and dimensions of pump and water-plungers: Built by the Blake Manufacturing Company; plain plungers, 6 inches diameter, 8 inches stroke, 90 strokes per minute; pump-barrels, 8 by 6 inches.
Time pump is run: 6 days per month.
Time spent in repairs: About 20 hours per year.
Description of force-main: 2,500 feet long, 8 inches diameter, 95 pounds pressure on pump.
Description of water-valves: Puppet, 3 inches diameter, 3½ inches lift.
Kind of power used: Steam.
Description of boiler: One tubular, 12 feet long, 40 inches diameter, 60 pounds pressure.
Description of engine: Non-condensing, 90 strokes per minute; slide-valves.
Cost of engine and pump: $800.

IOWA.

MUSCATINE:
Population: 8,295 inhabitants.
Name of corporation: Muscatine Water-Works Company (private).
Water obtained from: Mississippi river.
Capacity of reservoir: 1,500,000 gallons.
Cost of dam: $11,000.
Water first introduced: In 1876.
Description of main conduit: 700 feet long, 18 inches diameter; iron.

MUSCATINE—Continued.
Description of distributing reservoir: Puddled and faced with two thicknesses of brick laid in cement; discharge-pipe enters at bottom; depth of water, 20 feet; overflow 2 feet from top.
Sizes of distributing mains: 12, 10, and 6 inches.
Available head: 180 feet (average).
Total length of distributing mains: 4½ miles.
Number of water-takers: 300.
Consumption of water: 200,000 gallons per day (estimated).
First cost of water-works: $62,000.
Average annual cost of maintenance and repairs: $3,500.
Number of fire-plugs: 42.
Design and dimensions of pump and water-plungers: Built by Cope & Maxwell, Hamilton, Ohio; two plain plungers, 10 inches diameter, 36 inches stroke, 25 strokes per minute; pump-barrels, 10 by 30 inches.
Time pump is run: 4 days per week.
Description of force-main: ½ mile long, 10 inches diameter, 80 pounds pressure on pump.
Description of water-valves: Rubber, 8 inches, 1 inch lift.
Kind of power used: Steam.
Description of boilers: Tubular, 12 feet long, 48 inches diameter; flues, 3 inches diameter, 80 pounds pressure.
Description of engine: Non-condensing; cylinder, 18 inches diameter, 36 inches stroke, 20 to 35 strokes per minute; combination and slide-valves.
Cost of engine and pump: $8,000.

MARYLAND.

BALTIMORE:
Population: 332,313 inhabitants.
Name of corporation: City Water-Works (municipal).
Water obtained from: Jones' falls and Gunpowder river.
Area and capacity of reservoirs: Jones' Falls supply, 116 acres, 400,000,000 gallons; Gunpowder River supply, 252 acres, 510,000,000 gallons.
Character and dimensions of dams: Lake Roland, rubble and cut stone on rock, backed with clay, 330 feet long; thickness of masonry at foundation of overfall, 60 feet. Loch Raven, built same, 556 feet long; thickness of masonry at foundation of overfall, 62 feet. Both 20 feet high, backed with 50 feet of clay at foundation.
Cost of dams: Lake Roland, $152,000; Loch Raven, $250,000; reservoirs cost $2,695,000.
Water first introduced: In 1870.
Description of main conduits: Jones' falls, 3.8 miles long, oval, 5 feet wide, 6⅛ feet high, area, 24¼ square feet; built of stone and brick masonry; fall, 1 foot per mile. Gunpowder, a tunnel, 7 miles long, 2 miles arched with brick, 5 miles through solid rock; circular; diameter, 12 feet; fall, same as the other.
Discharging capacity: Jones' falls, 36,000,000 gallons per day; head, 5 feet. Gunpowder, 170,000,000 gallons per day; head, 7 feet.
Description of distributing reservoirs: Various forms; earth and clay, lined on each side with stone; outside slopes all 2 to 1; inside slopes, 1½ to 1, 3 to 1, and 4 to 1; puddled cores in all embankments going below bottom of basin and running well up into excavation on the sides; width of embankment, 15 feet; for lakes, 60 and 80 feet.
Sizes of distributing mains: 40 to 3 inches.
Available head: Water-supply slightly deficient at dividing line of service.
Total length of distributing mains: 278 miles.
Number of water-takers: 48,669.
Consumption of water: 45 gallons per head per day (estimated).
First cost of water-works: Purchased from old water company for $3,500,000.
Average annual cost of maintenance and repairs: $3,500.

BALTIMORE—Continued.

Number of fire-plugs: 825.

Design and dimensions of pumps and water-plungers: Built by H. R. Worthington, Brooklyn, New York; plain plungers, duplex; two sets, 17¼ inches diameter, 36 inches stroke; two sets, 22 inches diameter, 48 inches stroke; 24 strokes per minute.

Time pumps are run: Two sets 98 days per year; two sets 60 days per year.

Time spent in repairs: Two sets 50 hours per year, and two sets 75 hours per year.

Description of force-mains: 6,100 feet long, 60 pounds pressure on pumps; 3½ miles long, 85 pounds pressure on pumps.

Description of water-valves: Worthington gum disks.

Kind of power used: Steam.

Description of boilers: Horizontal tubular, 45 pounds pressure; fuel, bituminous and semi-bituminous coal.

Description of engines: Worthington compound duplex, 24 strokes per minute; slide-valves operated by opposite engine; lifting-pump cylinder-condenser.

Cost of engines and pumps: Two sets $46,000; two sets $85,000.

MASSACHUSETTS.

CHELSEA:

Population: 21,782.

Supplied by Boston water-works.

DORCHESTER:

Population: (Included in Boston.)

Supplied by Boston water-works.

HAVERHILL:

Population: 18,472 inhabitants.

Name of corporation: Haverhill Aqueduct Company (private).

Water obtained from: Kenoga, Saltonstall, and Pentucket lakes.

Water first introduced: In 1802.

Description of main conduit: 16, 12, and 10 inches diameter; wrought iron and cement; head, 256 feet (average).

Description of distributing reservoir: Wrought iron, 40 feet high, 30 feet diameter, with stand-pipe in center 50 feet high, 24 inches diameter.

Sizes of distributing mains: 12, 10, 8, 6, and 4 inches.

Available head: 150 feet (average).

Total length of distributing mains: About 25 miles.

Number of water-takers: About 2,000.

Consumption of water: 100 gallons per head per day (estimated).

First cost of water-works: $350,000.

Average annual cost of maintenance and repairs: $8,000.

Number of fire-plugs: 20; 63 hydrants.

Design and dimensions of pumps and water-plungers: Built by H. R. Worthington, New York, in 1879; two, compound duplex; capacity, 2,000,000 gallons per day.

Time pumps are run: One, 12 hours per day.

Description of force-main: 3,000 feet long 16 inches diameter; head, 156 feet on pumps.

Kind of power used: Steam.

Description of boiler: Horizontal tubular, 60 horse-power; fuel, hard coal.

Description of engine: Worthington, compound duplex.

Cost of engine and pumps: $25,000.

NEW JERSEY.

BURLINGTON:

Population: 6,090 inhabitants.

Style of corporation: Municipal.

Water obtained from: Delaware river mainly.

Capacity of reservoir: 90,000 gallons.

Water first introduced: In 1804.

BURLINGTON—Continued.

Description of distributing reservoirs: Eight, iron; seven of them 7 feet diameter, 9 feet high; one, 20 feet diameter, 25 feet high; inclosed in building for the purpose.

Sizes of distributing mains: 24, 16, 12, 10, 8, 6, and 4 inches.

Available head: 50 feet (average).

Total length of distributing mains: 9 miles.

Number of water-takers: 1,027.

Consumption of water: 140,000 gallons per day (exact).

First cost of water-works: $60,000.

Average annual cost of maintenance and repairs: $2,500.

Number of fire-plugs: 84.

Design and dimensions of pumps and water-plungers: Old, unknown; new, built by Worthington, New York, in 1878; two plain plungers, 10 inches diameter, 18½ inches stroke, 45 strokes per minute (average).

Time pumps are run: 6 hours per day.

Description of force-main: 12 inches diameter, 22 pounds pressure on pumps.

Description of water-valves: Gum, circular.

Kind of power used: Steam.

Description of boilers: Tubular, 40 horse-power, 50 pounds pressure; fuel, anthracite coal.

Description of engines: Compound condensing; high-pressure cylinder, 10 inches diameter; low-pressure cylinder, 24 inches diameter; 18½ inches stroke, 45 strokes per minute; ordinary slide-valves, worked by opposite engine; air-pump at end of pump on low-pressure side, same capacity as water-pump; condenser, 12 inches diameter, 3 feet high.

Cost of engines and pumps: About $5,200.

Remarks: The advantage of pumping to reservoir consists in this, that it gives security in case of fire.—Generally water is pure. In summer spongy fungus is sometimes found in the mains.

NEWARK:

Population: 136,508 inhabitants.

Name of corporation: The Newark Aqueduct Company (municipal).

Water obtained from: Passaic river at Belleville.

Total area of available water-shed: 981 square miles.

Cost of dams: $2,671,580 40.

Description of main conduit: 3 miles long, 30 inches diameter; iron; head, 165 feet (average).

Description of distributing reservoir: Surface elevation, 114 feet above tide-water; capacity, 22,000,000 gallons.

Sizes of distributing mains: 20 to 3 inches.

Available head: 114 feet (average); water-supply deficient.

Total length of distributing mains: 136 miles.

Number of water-takers: 11,000.

Consumption of water: 9,386,000 gallons per year (estimated).

First cost of water-works: $150,000.

Average annual cost of maintenance and repairs: $12,000.

Number of fire-plugs: 1,186.

Design and dimensions of pumps and water-plungers: Five, built by Worthington, New York city; two in 1869-'70, capacity, 5,000,000 gallons each; one in 1874, capacity, 8,000,000 gallons; one in 1876, capacity, 3,000,000 gallons. Plain plungers; on 5,000,000-gallon pumps, 22 inches diameter, 4 feet nominal stroke, 3 feet $\frac{9}{16}$ inch working stroke; on 8,000,000-gallon pump, 28 inches diameter, 50 inches full stroke, 4 feet 1½ inch working stroke; pump-barrels, 22 and 28 inches diameter.

Description of force-mains: 30 inches diameter; head, 165 feet on pumps.

Description of water-valves: Rubber, 9 and 10½ inches diameter; lift, about 1 inch.

Kind of power used: Steam.

Description of boilers: Seven tubular, 18 feet long, 5 feet diameter, and 18 feet long, 6 feet diameter; fuel, Schuylkill hard white-ash coal.

NEWARK—Continued.

Description of engines: Compound; one, high-pressure cylinder, 25 inches diameter; low-pressure cylinder, 43.3 inches diameter; 3.98 feet stroke; one, high-pressure cylinder, 29 inches diameter; low-pressure cylinder, 52 inches diameter; slide-valves; bucket air-pumps; jet-condenser.

Remark: Water much contaminated by factories above pumping works.

NEW YORK.

CANAJOHARIE:

Population: 2,013 inhabitants.
Name of corporation: Canajoharie Water-Works Company (private).
Water obtained from: Springs.
Capacity of reservoirs: Conduit, 8,000 to 10,000 gallons; tank, 800 gallons.
Cost of dam: $10,000.
Water first introduced: In 1852.
Description of main conduit: 90 feet long, 4 inches wide, 4 feet deep; stone wall in masonry, and clay puddling; head, 32 feet (average).
Description of distributing reservoir: Area, 16 by 26 feet, 3 feet deep.
Sizes of distributing mains: 12, 6, 4, 3, and 2 inches.
Available head: 40 to 70 pounds.
Total length of distributing mains: 10,019 feet.
Number of water-takers: 90.
Consumption of water: 75 gallons per head per day (estimated).
First cost of water-works: $10,000.
Average annual cost of maintenance and repairs: About $100.
Number of fire-plugs: 11.
Design and dimensions of pumps and water-plungers: Two, built by Rumsey & Co., Seneca Falls, New York; plain plungers, 4 by 16 inches diameter, 8 inches stroke, 6 to 8 strokes per minute; pump-barrel, 4 by 16 inches.
Time pumps are run: Constantly.
Time spent in repairs: Not over four hours per year.
Description of force-main: 11 miles long, 75 pounds pressure on pumps.
Description of water-valves: Brass.
Kind of power used: Water.
Description of water-wheel: Overshot, wooden, 12 feet diameter, 1 foot wide, with buckets 4 by 12 inches; home design; 6 feet head, 6 to 8 revolutions per minute; 51 gallons per minute; discharge, 6 gallons per minute at reservoir.
Cost of wheel and pumps: Wheel, etc., $200; pumps, $100.

CORNING:

Population: 4,802 inhabitants.
Name of corporation: Corning Water Works (private).
Water obtained from: McCulloch and Monkey Run creeks.
Capacity of reservoir: 1,500,000 gallons.
Cost of dam: $4,000.
Water first introduced: In 1870.
Description of main conduit: 8 and 6 inches diameter; cast iron.
Discharging capacity: 500,000 gallons per day; head, 50 feet (average).
Description of distributing reservoir: Area, 300 by 150 feet, and 20 feet deep.
Sizes of distributing mains: 12, 10, 8, 6, and 4 inches.
Available head: 230 feet (average).
Total length of distributing mains: About 5 miles.
First cost of water-works: $25,000.
Number of fire-plugs: 40.
Design and dimensions of pumps and water-plungers: Built by George F. Blake Manufacturing Company and by La France Manufacturing Company, Elmira, New York, in 1877; plain plunger, 24 by 14 inches.
Time pumps are run: About half the time.
Description of force-main: 1¼ mile long, 6 inches diameter; 130 pounds pressure on pumps.

CORNING—Continued.

Description of water-valves: Rubber, 7 inches diameter.
Kind of power used: Steam.
Description of boilers: 14 feet long, 3½ feet diameter.
Description of engines: Simple, one 24 by 24 inches, and one 24 by 12 inches, 40 to 125 strokes per minute.
Cost of engines and pumps: $5,000.

ELMIRA:

Population: 20,541 inhabitants.
Name of corporation: Elmira Water-Works Company (private).
Water obtained from: (A) supply, Carr's creek; (B) supply, Chemung river.
Total area of water-shed available: (A) supply, 20 square miles.
Character and dimensions of dam: Across ravine forming storage reservoir, 770 feet long, 36 feet high; built of earth; clay and puddled wall in center; slopes 2 to 1 on both sides; upper side lined; stone rip-rap 12 inches thick; flows 22 acres (about).
Cost of dams: First, $81,928 96; second, $10,718 33.
Water first introduced: In 1860.
Description of main conduits: Two pipes, 10 inches diameter, sheet-iron and cement lined; one Wyckoff patent wood pipe, 2 miles long, 12 inches diameter; head, 88 feet (average).
Description of distributing reservoir: Area, about 300 feet square; elevation, 88 feet; capacity, 6,000,000 gallons; water from distributing reservoir is let in through a fountain discharging-trough; cluster of holes for aerating and purifying.
Sizes of distributing mains: 10 to 2 inches.
Available head: 60 feet (average).
Total length of distributing mains: About 27 miles.
Number of water-takers: 772.
Consumption of water: 1,400,000 gallons (estimated).
First cost of water-works: $342,455 79.
Average annual cost of maintenance and repairs: $9,000.
Filtering apparatus: Gallery; 75 feet long, 75 feet distant from river; bottom 5 feet below low-water; gravel; no cleaning.
Number of fire-plugs: 148.
Design and dimensions of pumps and water-plungers: One rotary, built by La France Manufacturing Company, Elmira, New York; one Knowles pump, Warren, Massachusetts, in 1880; plain plunger, 22 inches diameter, 36 inches stroke, 28 strokes per minute; pump-barrel, 22 inches diameter.
Time pumps are run: Constantly for 6 months.
Description of force-main: 12 inches diameter.
Description of water-valves: Rubber, 3 inches diameter, 2 inches lift.
Kind of power used: Steam.
Description of boilers: Two; 60-horse power, 40 to 60 pounds pressure; fuel, bituminous coal, from McIntyre mines.
Description of engine: Knowles simple condensing; cylinder, 30 inches diameter, 36 inches stroke, 28 strokes per minute, slide-valves operated by piston; Knowles condenser.
Cost of engine and pumps: Knowles, about $5,000.

PORT BYRON:

Population: 1,146 inhabitants.
Style of corporation: Municipal.
Water obtained from: Owasco lake.
Cost of dam: $1,600.
Water first introduced: In 1872.
Description of main conduit: 175 feet long, 4 and 6 inches diameter; iron.
Description of distributing reservoir: Area, 155 by 50 feet, and 12 feet deep.
Sizes of distributing mains: 6 and 4 inches.
Available head: 175 feet (average).
Total length of distributing mains: 3½ miles.
Number of water-takers: 30.
First cost of water-works: $10,000.
Average annual cost of maintenance and repairs: $150.
Number of fire-plugs: 30.

PORT BYRON—Continued.

Design of pump and water-plungers: Built by Rumsey, Seneca Falls, New York.

Description of water-wheel: Turbine, 36 inches diameter, 7 feet head, 150 revolutions per minute.

PENNSYLVANIA.

BELLEFONTE:

Population: 3,026 inhabitants.

Style of corporation: Municipal.

Water obtained from: Spring discharging 14,600 gallons per minute.

Capacity of reservoir: 300,000 gallons.

Cost of dam: $75,000 to $80,000.

Water first introduced: In 1830.

Description of main conduit: 6 inches diameter.

Description of distributing reservoir: Built in shape of section of pyramid, small end down; stone and brick, cemented; no cover; capacity, 300,000 gallons; 1,900 feet from and 196 feet above spring.

Size of distributing mains: 6 inches.

Available head: 10 to 200 feet.

Total length of distributing mains: ¾ mile.

Number of water-takers: 500.

Consumption of water: 80 to 100 gallons per head per day (estimated).

Average annual cost of maintenance and repairs: $2,000.

Number of fire-plugs: 40.

Design and dimensions of pumps and water-plungers: Steam-pump built by Knowles, Warren, Massachusetts; plain plunger, 24 inches diameter, 45 strokes per minute; pump-barrel, 24 inches diameter. Water-pump built by W. P. Duncan & Co., Bellefonte, Pennsylvania; plunger, 32 inches stroke, 18½ strokes per minute; pump-barrel, 6 inches diameter.

Time pumps are run: Water, constantly; steam, 2 to 3 hours per day.

Description of force-main: 1,900 feet long, 82¾ pounds pressure on pumps.

Description of water-valves: 3 inches diameter.

Kind of power used: Steam and water.

Description of water-wheel: Horizontal, 35 inches diameter, 6 feet head, 90 revolutions per minute; 100 gallons required to lift 1 gallon to reservoir.

Description of boilers: Tubular, 14 feet long, 4 feet diameter; fuel, Snowshoe coal.

Description of engine: Simple; 45 strokes per minute; ordinary valves.

COLUMBIA:

Population: 8,312 inhabitants.

Name of corporation: Columbia Water Company (private).

Water obtained from: River and springs.

Total area of water-shed available: About 2 square miles.

Capacity of reservoirs: 2,000,000 gallons each.

Character and dimensions of dam: Across valley; 250 feet long at top, 20 feet deep; 500 feet long at bottom, 250 wide.

Cost of dam: $4,281 51; reservoir, $15,778 79.

Water first introduced: In 1823.

Description of main conduit: 10 miles long; diameters, 12, 6, and 4 inches; iron.

Discharging capacity: 1,000,000 gallons; 150 feet head (average) of spring above; reservoir, 50 feet head (average).

Description of distributing reservoirs: Two; area, 100 by 150 feet; 9 feet deep each; plank bottom and sides, caulked and pitched; earth embankment 9 feet above ground level.

Sizes of distributing mains: 12, 10, 8, 6, and 4 inches.

Available head: 50 to 75 feet.

Total length of distributing mains: 10 miles.

Consumption of water: 75 gallons per head per day.

First cost of water-works: $15,500.

Average annual cost of maintenance and repairs: $4,000.

Number of fire-plugs: 50.

COLUMBIA—Continued.

Design and dimensions of pumps and water-plungers: Built by Morris, Tasker & Co., Philadelphia, Pennsylvania, and one by Worthington; two plungers, Worthington, iron, with brass packing, 12 inches diameter, 25 strokes per minute; pump-barrel, 12 inches diameter.

Time pumps are run: 10 to 18 hours per day.

Description of force-main: 4,500 feet long; head, 150 feet on pumps, or 9,000 pounds.

Description of water-valves: Gum, ½ and 3 inches.

Kind of power used: Steam.

Description of boilers: Two; plain cylinder, 65 to 70 pounds pressure, and one flue-boiler.

Description of engine: Non-condensing simple; cylinders, 18 inches diameter, 50 strokes per minute; globe-valves.

Cost of engine and pumps: About $10,000.

Duty of engine: 3,400,000 foot-pounds per 15 hours daily.

LEWISTOWN:

Population: 3,222 inhabitants.

Name of corporation: Lewistown Water Company (private).

Water obtained from: Creek and springs.

Total area of water-shed available: About 4 square miles.

Area and capacity of reservoir: 2,500 sq. feet; 17,500 cu. feet.

Cost of dam: $24,000.

Water first introduced: In 1839.

Description of main conduit: 3 miles long, 6 inches diameter; iron; head, 80 feet (average).

Description of distributing reservoir: Ordinary; 50 feet square and 7 feet deep.

Sizes of distributing mains: 6 and 4 inches.

Available head: About 50 feet (average).

Total length of distributing mains: 5 miles.

Number of water-takers: About 500.

First cost of water-works: $20,000.

Average annual cost of maintenance and repairs: $1,500.

Number of fire-plugs: 14.

Design and dimensions of pump and water-plungers: Built by Worthington, New York, in 1870; two plain plungers, 6 inches diameter, 8 inches stroke, 60 strokes per minute.

Time spent in repairs: 75 hours per year.

Description of force-main: 1½ mile long; head, 15 feet on pump.

Description of water-valves: Rubber, 2 inches, ½ inch lift.

Kind of power used: Steam.

Description of boilers: Tubular, 8 feet long, 3 feet diameter; fuel, bituminous coal.

Description of engine: 60 strokes per minute; globe-valves; Worthington duplex pump condenser, etc.

Cost of engine and pump: $3,000.

Remarks: The disadvantage of pumping to mains is that when water is being shut off at the hydrants it is forced back on pumps, causing wear.—When pumping from creek after rain water is muddy; water is a little hard on account of limestone.

VIRGINIA.

STAUNTON:

Population: 6,664 inhabitants.

Name of corporation: City Water-Works (municipal).

Water obtained from: Springs.

Capacity of reservoir: 2,500,000 gallons.

Cost of dam: $82,000.

Water first introduced: In 1876.

Description of main conduit: 5,692 feet long, 12 inches diameter; cast iron.

Discharging capacity: Head, 180 feet (average); 1,125,000 gallons per day.

Description of distributing reservoir: Circular, 225 feet diameter at top, 16 feet deep; has a receiving well with a wire strainer through which the water passes.

Sizes of distributing mains: 12, 6, and 3 inches.

Available head: 180 feet (average).

Total length of distributing mains: About 8 miles.

STAUNTON—Continued.

Number of water-takers: 1,500.
Consumption of water: 67 gallons per head per day (estimated).
Average annual cost of maintenance and repairs: $2,600.
Number of fire-plugs: 28.
Design and dimensions of pump and water-plungers: Built by H. R. Worthington, New York; two plain plungers, 13 inches diameter, 24 inches stroke, 15 strokes per minute; pump barrel, 23 by 56 inches.
Time pump is run: 10.53 hours of 300 days per year.
Time spent in repairs: 7 to 8 days per year.
Description of force-main: 1,500 feet long, 12 inches diameter, 77 pounds pressure on pump.
Description of water-valves: Gum.
Kind of power used: Steam.
Description of boilers: 16 feet long, 5 feet diameter; fuel, New River soft coal.
Description of engine: *Condensing duplex compound*; high-pressure cylinder, 17¼ inches diameter; low-pressure cylinder, 35 inches diameter; 24 inches stroke, 15 strokes per minute; slide-valves; ordinary lifting air-pumps, 6 inches; condenser, 24 by 48 inches.
Cost of engine and pumps: $13,500.
Duty of engine: 42,269,392 foot-pounds daily.

755

WASHINGTON TERRITORY.

OLYMPIA:

Population: 1,232 inhabitants.
Name of corporation: *Olympia Water Company (private).*
Water obtained from: Springs and river.
Cost of dam: $500.
Water first introduced: In 1865.
Description of main conduit: Wyckoff wood pipe, 4 inches diameter; head, 150 feet (average).
Description of distributing reservoir: Tank, 50 feet square and 12 feet deep.
Sizes of distributing mains: 6 and 4 inches.
Available head: 80 feet (average).
Total length of distributing mains: 9 miles.
Number of water-takers: 100.
First cost of water-works: $20,000.
Number of fire-plugs: 2.
Design and dimensions of pump and water-plungers: Hooker pump, 90 strokes per minute; pump-barrel, 6 inches diameter.
Time pump is run: Constantly.
Description of water-valves: Composition rubber.
Kind of power used: Water.
Description of water-wheel: Leffel turbine, 23 inches diameter, 31 feet head, 320 revolutions per minute.

WATER-WORKS EMPLOYING THE GRAVITY SYSTEM AND PUMPING TO STAND-PIPE.

MINNESOTA.

STILLWATER:

Population: 9,055 inhabitants.
Name of corporation: Stillwater Water Company (private).
Water obtained from: Lake McKussick.
Total area of water-shed available: 40 square miles.
Area of reservoir: Lake, 30 acres.
Character and dimensions of dams: Filtering, 100 by 60 feet, and 10 feet deep; reservoir, 100 by 150 feet, and 12 feet deep.
Cost of dams: $4,000.
Water first introduced: December, 1880.
Description of main conduit: 200 feet long, 20 inches diameter; tile.
Discharging capacity: 5,000,000 gallons per day; head, 8 to 10 feet.
Description of stand-pipes: Tanks, on two hills; capacity, 100,000 gallons each; 1 mile from pumping station.
Sizes of distributing mains: 16, 12, 10, 8, 6, and 4 inches.
Available head: 50 to 200 feet.
Total length of distributing mains: 7⅓ miles.
Number of water-takers: 61.
Consumption of water: 25 gallons per head per day (estimated).
First cost of water-works: $150,000.
Filtering apparatus: Gallery, 60 by 100 feet, and 10 feet deep; sand and gravel, underlaid by 4 by 4 inch and 2½ by 4 inch timbers; cleaned once a year.
Number of fire-plugs: 85.
Design and dimensions of pump and water-plungers: Harrison, built by Blake Manufacturing Company, Boston, Massachusetts; piston, 1 to 150 strokes per minute; pump-barrels, 10 by 24 inches.
Time pump is run: 2 hours per day.
Description of force-main: 3 miles long, 16, 12, and 8 inches diameter, 60 pounds pressure on pump.
Description of water-valves: Har rubber, 4 inches diameter, ⅝ inch lift.
Kind of power used: Steam.
Description of boilers: Two; 16 feet long, 48 inches diameter.
Description of engine: High-pressure, 24 inches stroke, 1 to 150 strokes per minute; slide-valves operated with piston-valves.
Cost of engine and pump: $4,500.

PENNSYLVANIA.

SOUTH BETHLEHEM:

Population: 4,925 inhabitants.
Name of corporation: South Bethlehem Gas and Water Company (private).
Water obtained from: Lehigh river.
Water first introduced: In 1875.
Sizes of distributing mains: 8, 6, 4, and 3 inches.
Available head: 60 pounds pressure (average).
Total length of distributing mains: 2,305 feet.
Number of water-takers: 140.

SOUTH BETHLEHEM—Continued.

First cost of water-works: $29,184 22.
Average annual cost of maintenance and repairs: $395 83.
Number of fire-plugs: 36.
Design and dimensions of pumps and water-plungers: John Fritz, built by Bethlehem Iron Company; pump-barrels, 18 by 36 inches.
Time pumps are run: One pump constantly.
Description of force-main: 60 to 90 pounds pressure on pumps.
Kind of power used: Steam.
Remarks: The disadvantage of pumping to mains is that muddy water is pumped into mains after rains.

TENNESSEE.

CLARKSVILLE:

Population: 3,880 inhabitants.
Name of corporation: Clarksville Water Company (private).
Water obtained from: Cumberland river.
Water first introduced: June, 1879.
Description of main conduit: 10,200 feet long, 8 inches diameter; cast iron.
Discharging capacity: 500,000 to 1,000,000 gallons per day; head, 150 to 250 feet.
Description of stand-pipe: Riveted plate iron; 15 feet interior diameter; 102 feet high; on stone foundation.
Sizes of distributing mains: 8, 6, and 4 inches.
Available head: 150 to 200 feet.
Total length of distributing mains: $5\frac{2}{2}\frac{0}{6}\frac{0}{0}$ miles.
Number of water-takers: 102.
Consumption of water: 31 gallons per head per day (estimated).
First cost of water-works: $50,000.
Average annual cost of maintenance and repairs: $2,500.
Number of fire-plugs: 40.
Design and dimensions of pumps and water-plungers: Two; built by Blake Manufacturing Company, Boston, Massachusetts; bucket-plungers; steam, 20 inches; water, 12 by 24 inches; 45 strokes per minute; pump-barrel, 12 inches diameter.
Time pumps are run: Five hours per day, four days per week.
Description of force-main: 10,200 feet long, 8 inches diameter; head, 281 feet on pumps.
Description of water-valves: Composition of gum and metal; 4¼ inches diameter, 1 inch lift.
Kind of power used: Steam.
Description of boilers: 22 feet long, 44 inches diameter; 5 riveted flues, 8 inches diameter; fuel, bituminous coal.
Description of engine: Simple; high-pressure; cylinder, 20 inches diameter, 24 inches stroke, 45 strokes per minute; Blake patent valves.
Cost of engine and pumps: $3,000.
Remarks: The disadvantage of pumping is the uneven strain on pipe-joints.—Water slightly impregnated with lime.

WATER-WORKS EMPLOYING THE GRAVITY SYSTEM AND PUMPING DIRECT INTO DISTRIBUTING MAINS.

NEBRASKA.

OMAHA:

Population: 30,518 inhabitants.
Name of corporation: City Water-Works (private).
Water obtained from: Missouri river.
Capacity of reservoir: 9,000,000 gallons.
Description of main conduit: 16 and 24 inches diameter; cast iron.
Discharging capacity: 5,000,000 gallons per day of 12 hours; head, 235 feet (average).
Description of distributing reservoir: Two chambers, 204 by 162 feet; 24 feet deep, each; embankment, 12 feet wide at top; slopes, 1½ to 1; elevation of top of embankment, 307 feet above low water of river; interior puddled and lined with broken stone at bottom, and brick on slopes.
Sizes of distributing mains: 24 to 8 inches.
Available head: 150 feet (average).
Total length of distributing mains: 31 miles.
Number of water-takers: 395.
Consumption of water: 50 gallons per head per day (estimated).
First cost of water-works: $500,000.
Filtering system: Water pumped from river into three settling basins, capacity 3,000,000 gallons, from whence it is drawn into clear water basin, and from thence into distributing reservoir.
Number of fire-plugs: 250.
Design and dimensions of pumps and water-plungers: Knowles plain compound, 24 inches diameter, 42 inches stroke; high pressure, 19 inches diameter, 36 inches stroke; pump barrel, 24 inches diameter.
Time pumps are run: 12 hours per day.
Description of force-main: 2½ miles long, 16 inches diameter; head, 283 feet; pumps.
Description of water-valves: Rubber, with leather face, 3½ inches in size, ½ to ⅝ inch lift.
Kind of power used: Steam.
Description of boilers: Return-flue; fuel, bituminous coal.
Description of engines: One compound condensing; high-pressure cylinder, 33 inches diameter; low-pressure cylinder, 61 inches diameter; 42 inches stroke. One extra engine; cylinder, 38 inches diameter; 36 inches stroke; rotary piston; slide-valves, operated by rocker-valve attached to piston; air-cylinder, 16 inches diameter; one 30-inch jet-condenser.
Cost of engines and pumps: $10,000.
Duty of engines: 80,000,000 foot-pounds guaranteed.

NEW YORK.

YONKERS:

Population: 18,892 inhabitants.
Name of corporation: Yonkers Water-Works (municipal).
Water obtained from: Sprain and Grassy Sprain brooks.
Total area of water-shed available: 8 square miles possible; 6 square miles at present.

YONKERS—Continued.

Area and capacity of reservoir: 104 acres; 405,000,000 gallons.
Character and dimensions of dam: Earth, with puddle core; width on top, 20 feet; slopes, 2 to 1; faced on water side with rubble 18 inches thick; greatest depth of water, 26 feet; foundation mainly on sand and gravel, also on rock and hard pan; heavy base of concrete for puddle-wall, secured by sheet-piling and core-walls where necessary.
Cost of dam: $73,000.
Water first introduced: September, 1876.
Description of main conduit: 3,200 feet long, 24 inches diameter; cast iron.
Discharging capacity: About 4,000,000 gallons per day; head, 26 feet (maximum).
Description of distributing reservoir: Very small affair; holds about 2 days' supply.
Sizes of distributing mains: 18, 12, 8, 6, and 4 inches.
Available head: 0 to 297 feet.
Total length of distributing mains: 6,500 feet of 18 inches, 25,951 feet of 12 inches, 15,863 feet of 8 inches, 47,042 feet of 6 inches, 14,619 feet of 4 inches.
Number of water-takers: 995.
Consumption of water: 80 gallons per head per day (estimated).
First cost of water-works: To December 1, 1880, $669,299 66.
Average annual cost of maintenance and repairs: $3,500.
Number of fire-plugs: 248.
Design and dimensions of pumps and water-plungers: One built by W. Wright, Newburg, New York, in 1876; one bucket-plunger, 15½ inches diameter, 36 inches stroke, 17 strokes per minute; pump-barrel, 22 inches diameter. One H. R. Worthington, New York, in 1881; two plain plungers, 18½ inches diameter, 36 inches stroke, 50 strokes per minute.
Time pumps are run: 3,274 hours in 1880.
Time spent in repairs: Nominal.
Description of force-main: 8,500 feet long, 18 inches diameter; head on Wright pump, 198 feet; head on Worthington pump, 210 feet.
Description of water-valves: Wright, double-beat; Worthington, disk.
Kind of power used: Steam.
Description of boilers: Drop return tubular, 18 feet long, 5½ feet diameter; fuel, anthracite coal.
Description of engines: Condensing compound; Wright, 22 and 36 inches diameter, 5 feet stroke, 17 strokes per minute; slide-valves operated by eccentric on shaft. Worthington 31 and 36¾ inches diameter, 3 feet stroke, 50 strokes per minute; balanced slide-valve; single-acting, brass-lined air-pumps.
Cost of engines and pumps: Wright, $17,500; Worthington, $21,000.
Duty of engines: Wright, 61,000,000 foot-pounds daily in 1880; 80,000,000 foot-pounds guaranteed. Worthington, 70,000,000 foot-pounds guaranteed.

PENNSYLVANIA.

SHAMOKIN:

Population: 8,184 inhabitants.
Name of corporation: Shamokin Water Company (private).
Water obtained from: Trout run.
Total area of water-shed available: 2,000 acres.
Capacity of reservoir: 250,000 cubic feet.
Character and dimensions of dams: Two; one ¼ mile above the other.
Cost of dams: $4,000.
Water first introduced: In 1874.
Description of main conduit: 2¼ miles long, 12 inches diameter; wood, iron bound; and 3¾ miles long, 12 inches diameter, iron.
Discharging capacity: Lower dam, 49 feet, upper dam, 139 feet; 800 gallons per minute.
Description of stand-pipe: 250 feet, up the mountain.
Sizes of distributing mains: 10 to 4 inches.
Available head: 139 feet (average).
Total length of distributing mains: About 9 miles.
Number of water-takers: About 1,000.
Consumption of water: 100 gallons per day per family (estimated).
First cost of water-works: $110,000.
Average annual cost of maintenance and repairs: $2,000 to $3,000.
Number of fire-plugs: 20.
Design and dimensions of pumps and water-plungers: Built by the Niagara Pump Works, Brooklyn, New York; double plungers, 8½ inches diameter, 18 inches stroke, 20 to 40 strokes per minute; pump-barrel, 8½ inches diameter.
Time pumps are run: About 3 months per year.
Time spent in repairs: 600 hours per year.
Description of water-valves: Brass.
Kind of power used: Steam.
Description of boilers: Steam, from Cameron colliery; fuel, anthracite coal.
Cost of engine and pump: $750.

WILKESBARRE:

Population: 23,339 inhabitants.
Name of corporation: Wilkesbarre Water Company (incorporated stock company).
Water obtained from: Mountain stream.
Total area of water-shed available: About 12,000 acres.
Capacity of reservoir: 7,000,000 gallons.
Character and dimensions of dam: Stone, 20 feet high.
Cost of dam: $15,000.
Water first introduced: In 1860.
Description of main conduit: 2½ miles, 16 inches diameter, cast iron; and 2½ miles, 10 inches diameter, wrought iron and cement; head, 150 feet (average).
Sizes of distributing mains: 10, 8, 6, 4, and 3 inches.
Available head: 150 feet (average); water-supply deficient.

WILKESBARRE—Continued.

Total length of distributing mains: About 35 miles.
Number of water-takers: About 2,800.
First cost of water-works: $180,000.
Average annual cost of maintenance and repairs: $2,000.
Number of fire-plugs: 94.
Design and dimensions of pump and water-plungers: Built by G. F. Blake Manufacturing Company, in 1877; bucket-plungers, 50 to 60 strokes per minute; pump-barrels, 10 inches diameter; head, 130 feet on pumps.
Time pump is run: 2 days per year (average).
Description of water-valves: Leather.
Kind of power used: Steam.
Description of boilers: 55 pounds pressure; fuel, No. 3 anthracite coal.
Description of engine: 50 to 60 strokes per minute.
Cost of engine and pump: $2,100.
Remarks: The advantages of pumping to mains are that it saves trouble and that it is easy to get the water quickly.

VERMONT.

SAINT JOHNSBURY:

Population: 5,800 inhabitants.
Name of corporation: Saint Johnsbury Aqueduct Company and Village of Saint Johnsbury Water-Works (private).
Water obtained from: Saint Johnsbury Aqueduct, springs; Village, from river.
Total area of water-shed available: 1,000 acres.
Water first introduced: Saint Johnsbury Aqueduct, in 1860; Village, in 1876–'77.
Description of main conduit: Saint Johnsbury Aqueduct Company, 4 miles long, 6 inches diameter; iron, cement-lined; head, 170 feet (average).
Sizes of distributing mains: Saint Johnsbury Aqueduct Company, 4 and 3 inches; Village, 8, 6, and 4 inches.
Available head: 170 feet (average).
Consumption of water: 2,000 gallons per day (estimated).
First cost of water-works: Saint Johnsbury Aqueduct Company, $50,000; Village, $80,000.
Filtering apparatus: Size, 12 by 15 feet; filled with sand; cleaned once in two weeks.
Number of fire-plugs: 50.
Design and dimensions of pumps and water-plungers: Village pumps, built by J. P. Flanders, Vergennes, Vermont, in 1874; buckets, small pump, 18 inches stroke; large pump, 8 inches stroke; 20 strokes per minute; pump-barrels, 12 by 15 inches; 80 to 100 pounds pressure on pumps.
Time pumps are run: Constantly.
Description of water-valves: Plain metallic; small pump, 12 inches and ¾ inch lift; large pump, 15 inches and ¾ inch lift.
Kind of power used: Water.
Description of water-wheels: One for each pump; Buzzell make; 30 and 50 inches diameters; 12 feet head.

WATER-WORKS EMPLOYING SYSTEM OF PUMPING TO DISTRIBUTING RESERVOIR AND STAND-PIPE.

ALABAMA.

MOBILE:

Population: 29,132 inhabitants.
Name of corporation: Mobile Water Company (private).
Water obtained from: Springs and creek.
Water first introduced: In 1824.
Description of distributing reservoir and stand-pipe: Rectangular embankment; puddle-faced and riprap of brick; inner slope, 2 to 1; outer slope, 1½ to 1; stand-pipe, cast iron, 9 inches diameter, 85 feet high, with an exterior of 3 inches; pipe, 12 feet high; the whole supported in a skeleton framework.
Sizes of distributing mains: 14, 10, 8, 6, and 4 inches.
Water supply: Deficient.
Number of water-takers: About 1,000.
Consumption of water: About 250,000 gallons per day.
First cost of water-works: $200,000.
Average annual cost of maintenance and repairs: $12,000.
Number of fire-plugs: 172.
Design and dimensions of pumps and water-plungers: Two; built by Paulding, Kemple & Co., West Point; plain double-acting piston-plunger; 10 inches diameter; 48 inches stroke; 17 strokes per minute.
Time pumps are run: Constantly.
Description of force-main: 16,000 feet long; 8 inches diameter; head, 20 feet on pumps.
Description of water-valves: Hinge, 6 by 12 inches; free lift.
Kind of power used: Water.
Description of water-wheels: Two breast-wheels; 16 inches diameter; 7 feet wide; 10 inches deep; 5½ feet head; 8½ revolutions per minute.
Remarks: Two Blake pumps are being introduced.

MASSACHUSETTS.

BROOKLINE:

Population: 8,057 inhabitants.
Name of corporation: Brookline Water-Works (municipal).
Water obtained from: Springs.
Cost of dam: $78,312.
Water first introduced: May, 1875.
Description of distributing reservoir and stand-pipe: On a hill, 240 feet above tide-water; 360 by 130 feet; 20 feet deep; lined with stone rubble masonry; capacity, 6,000,000 gallons; partly built by embankment. Stand-pipe, 25 feet high; 6 feet inside diameter; built of masonry.
Sizes of distributing mains: 16 to 2 inches.
Available head: From 0 to 220 feet.
Total length of distributing mains: About 25 miles.
Number of water-takers: 896.
Consumption of water: 69 gallons per head per day (exact).
First cost of water-works: $475,000.

BROOKLINE—Continued.

Average annual cost of maintenance and repairs: $6,800.
Filtering apparatus: Size, 200 by 4 feet; filtering required only occasionally; gravel; cleaned once a month, while in use.
Number of fire-plugs: 158.
Design and dimensions of pumps and water-plungers: Built by Worthington, New York, in 1874 and 1880; two plain plungers; one 16 inches diameter and one 14¾ inches diameter; 25¾ inches stroke; 24 strokes per minute; pump-barrels, about 2 feet.
Time pumps are run: About 3,400 hours per year.
Time spent in repairs: 250 hours per year.
Description of force-main: 2¾ miles long; 16 and 14 inches diameter.
Description of water-valves: Vulcanized rubber; 7 by 1 inch; ¾ inch lift.
Kind of power used: Steam.
Description of boilers: Two horizontal tubular; 16 feet long; one 5 feet 3 inches diameter; one 5 feet 6 inches diameter; evaporation, 8½ pounds of water to 1 pound of coal; 55 pounds pressure; fuel, anthracite coal.
Description of engine: Compound condenser, intermediate receiver; high-pressure cylinder, 21½ inches diameter; low-pressure cylinder, 43½ inches diameter; 25¾ inches stroke; 48 strokes per minute; slide-balanced valves, worked by opposite bell-crank; two single-acting air-pumps, volume, 5,304 cubic inches; condenser volume, 25,000 cubic inches.
Cost of engine and pumps: $16,000.
Duty of engine: 53,000,000 foot-pounds, daily; 50,000,000 foot-pounds guaranteed.

CAMBRIDGE:

Population: 52,669 inhabitants.
Name of corporation: City Water-Works (municipal).
Water obtained from: Fresh pond.
Total area of water-shed available: 1,200 acres.
Water first introduced: In 1856.
Description of distributing reservoir and stand-pipe: Stand-pipe near reservoir; pumping mains enter it at bottom and connect with distributing mains, these connect with reservoir; an outlet from reservoir connects direct with stand-pipe.
Sizes of distributing mains: 24, 20, 16, 12, 10, 8, 6, 4, and 3 inches.
Available head: 60 feet (average); water-supply deficient.
Total length of distributing mains: 80 miles.
Number of water-takers: 10,400.
Consumption of water: 46 gallons per head per day.
First cost of water-works: $291,480.
Average annual cost of maintenance and repairs: $25,000.
Filtering apparatus: Gallery excavated near edge of little pond; size, 45 by 50 feet; gravel; no cleaning.

CAMBRIDGE—Continued.

Number of fire-plugs: 375.

Design and dimensions of pumps and water-plungers: Two built by Worthington, New York, in 1868 and 1872; two plain plungers to each; 22 inches diameter; 48 inches stroke; 26 strokes per minute; pump-barrels 22 by 48 inches.

Time pumps are run: 11 hours per day.

Description of force-main: 2,400 feet long; one 30 inches diameter and one 24 inches diameter; 48 pounds pressure on pumps.

Description of water-valves: Rubber; 9 inches diameter; ⅞ inch lift.

Kind of power used: Steam.

Description of boilers: Four horizontal tubular; two 13 feet long, 63 inches diameter; two 13 feet 6 inches long, 66 inches diameter; 45 pounds pressure; fuel, Cumberland coal.

Description of engine: Compound condensing; high-pressure cylinder, 14 inches diameter; low-pressure cylinder, 24 inches diameter; 48 inches stroke; 52 strokes per minute (average); slide-valves with piston counter-balance operated from opposite cross-head; single-acting air-pump; jet-condenser.

Cost of engine and pumps: $68,000.

Duty of engine: 50,000,000 foot-pounds daily.

OHIO.

WEST CLEVELAND:

Population: 1,800 inhabitants.

Supplied by Cleveland water-works (see pages 112 and 113).

ZANESVILLE:

Population: 18,113 inhabitants.

Name of corporation: City Water-Works (municipal).

Water obtained from: Muskingum river.

Water first introduced: In 1842.

Discharging capacity of conduit: 5,000,000 gallons in 24 hours; head, 180 feet (average).

Description of distributing reservoirs and stand-pipe: Two reservoirs for low service; capacity, 5,000,000 gallons; stand-pipe for high service; head, 80 feet above reservoir.

Sizes of distributing mains: 16 to 3 inches.

Available head: 180 feet (average).

Total length of distributing mains: 34 miles.

Number of water-takers: 3,000.

Consumption of water: 96 gallons per head per day (estimated).

First cost of water-works: $500,000.

Average annual cost of maintenance and repairs: $12,000.

Number of fire-plugs: 163.

Design and dimensions of pump and water-plunger: Worthington, New York, duplex; plain plunger, 18 inches diameter; 36 inches stroke; 60 strokes per minute; pump-barrel, 17¼ by 36 inches.

Time pump is run: 15 hours per day.

Description of force-main: 2,800 feet long; 20 inches diameter; 70 pounds pressure on pump.

Description of water-valves: Gum; 7 inches diameter; 1 inch lift.

Kind of power used: Steam.

Description of boilers: Four tubular; 14 feet long, 54 inches diameter; 60 tubes, 3 inches diameter each; 65 pounds pressure; fuel used, slack.

Description of engine: Non-condensing; cylinder, 30 inches diameter; 36 inches stroke; 60 strokes per minute; globe throttle-valves.

Cost of engine and pump: $17,000.

PENNSYLVANIA.

ALLENTOWN:

Population: 18,063 inhabitants.

Style of corporation: Municipal.

Water obtained from: Springs.

Character and dimensions of dam: Wooden structure; 140 feet wide and 6 feet high.

ALLENTOWN—Continued.

Water first introduced: In 1830.

Description of main conduit: 2,230 feet long; 12 inches diameter; cast iron.

Discharging capacity: 1,300,000 gallons in 24 hours; head, 6 feet (average).

Description of distributing reservoir and stand-pipe: The former, 48 by 28 feet and 13 feet deep; bottom 142 feet above level of pump; capacity, 276,019 gallons. The latter, 57 feet high, 6 feet diameter; base 128 feet above pump; capacity, 134,222 gallons.

Sizes of distributing mains: 16 to 2 inches.

Available head: 8 to 136 feet; water-supply deficient.

Total length of distributing mains: 22 miles.

Number of water-takers: 2,350.

Consumption of water: About 800,000 gallons per day (estimated).

First cost of water-works: $97,000.

Number of fire-plugs: 92.

Design and dimensions of pump and water-plungers: Built by W. F. Moser & Co., Allentown, Pennsylvania, in 1872; two plain plungers; 5 feet 2 inches; 12½ strokes per minute; pump-barrel, 10 inches diameter.

Time pump is run: Constantly.

Description of force-main: 1,000 feet long; 10 inches diameter; 142.5 pounds pressure on pump.

Description of water-valves: Brass; 10 by 14 inches; 1 inch lift.

Kind of power used: Water.

Description of water-wheel: Wolfe's patent turbine; 6 feet diameter; 6 feet head; 30 revolutions per minute.

WISCONSIN.

MILWAUKEE:

Population: 115,587 inhabitants.

Name of corporation: City Water-Works (municipal).

Water obtained from: Lake Michigan.

Water first introduced: In November, 1873.

Description of main conduit: From lake-crib to pump well, 2,100 feet long; 36 inches diameter; cast iron; the head or difference of level between lake and pump-well depends on speed of pumps, being 3 feet 2 inches when engines are pumping at the rate of 16,000,000 gallons per 24 hours.

Description of distributing reservoir and stand-pipe: Reservoir capacity, 21,000,000 gallons; embankment, 16 feet wide on top; inner slope, 1¾ to 1; outer slope, 1½ to 1; inner slope and bottom covered with, first, clay puddle 2 feet thick; second, 9 inches broken stone; third, paving 15 inches thick, laid in cement and mortar; water enters on east side; effluent-chamber, stop-valves, waste- and overflow-pipes on west side; influent- and effluent-pipes connected by main on bottom of reservoir for direct supply in case of necessity. Stand-pipe, wrought iron; 4 feet diameter; 130 feet high; inclosed in stone tower.

Sizes of distributing mains: 30, 24, 20, 16, 12, 8, and 6 inches.

Available head: 90 to 140 feet, according to location.

Total length of distributing mains: 90 miles.

Number of water-takers: 7,524.

Consumption of water: 12,269,000 gallons per day; about 100 gallons per head (average).

First cost of water-works: $1,067,500.

Average annual cost of maintenance and repairs: $60,000.

Number of fire-plugs: 716.

Design and dimension of pumps and water-plungers: R. W. Hamilton, built by E. P. Allis & Co., Milwaukee, Wisconsin, in 1873; two bucket-plungers; 28⅛ inches diameter; 7 feet stroke; 26 strokes per minute; pump-barrel, 3 feet 4 inches diameter.

Time pumps are run: About 18 hours per day.

MILWAUKEE—Continued.

Description of force main: 525 feet long; 36 inches diameter; head, about 170 feet on pumps.

Description of water-valves: Bucket, double-seated; outside diameter lower seat, 34 inches; inside diameter, 20 inches; 1¼ inch lift.

Kind of power used: Steam.

Description of boilers: Drop return-flue; 24 feet long; 7 feet diameter; 60 pounds pressure; evaporation, 9.15 pounds of water to 1 pound of coal; fuel, anthracite coal.

761

MILWAUKEE—Continued.

Description of engines: Condensing compound; *high-pressure* cylinder, 36 inches diameter, 62.14 inches stroke; low-pressure cylinder, 58 inches diameter, 96 inches stroke; 26 strokes per minute; ordinary steam-valve, operated by cam *cut-off*; single-acting air-pump, 30 inches diameter, 62 inches stroke; common condenser, 36 inches diameter, 84 inches high.

Cost of engines and pumps; $170,000.

Duty of engines: 75,000,000 to 80,000,000 foot-pounds, daily; 60,000,000 foot-pounds guaranteed.

WATER-WORKS EMPLOYING SYSTEM OF PUMPING TO DISTRIBUTING RESERVOIR AND MAINS.

ALABAMA.

BIRMINGHAM:

Population: 3,086 inhabitants.
Name of corporation: Elyton Land Company (private).
Water obtained from: Creek.
Total area of water-shed available: 40 square miles.
Capacity of reservoir: 1,000,000 gallons.
Cost of dam: $7,500.
Water first introduced: In May, 1873.
Description of main conduit: Part of stone, 30 by 30 inches square; part cast iron, 4,600 feet long; 12 inches diameter.
Discharging capacity: 3,000,000 gallons per day.
Description of distributing reservoir: Dimensions—58 by 95 feet, bottom; 100 by 150 feet, top; 12½ feet deep; embankment of earth, lined inside with one course of brick, and one edge laid in cement.
Sizes of distributing mains: 8, 6, 4, 3, and 2 inches.
Available head: 130 feet (average).
Total length of distributing mains: About 8 miles.
Number of water-takers: 450.
Consumption of water: 100 gallons per head per day (estimated).
First cost of water-works: About $90,000.
Average annual cost of maintenance and repairs: $300 to $500.
Number of fire-plugs: 15.
Design and dimensions of pumps and water-plungers: One Worthington; pump-barrel, 10 by 10 inches. One Blake; pump-barrel, 14 by 24 inches. One Williamson; pump-barrel, 10 by 24 inches; 100 strokes per minute.
Time pumps are run: 10 hours per day for 2 pumps.
Description of force-main: 4,600 feet long; 12 inches diameter; head, 175 feet on pumps.
Description of water-valves: Rubber; 3 and 3½ inches diameter; ¾ inch lift.
Kind of power used: Steam.
Description of boilers: Two—14 feet long, 50 inches diameter; 60 tubes 3 inches diameter in each. One flue—28 feet long, 42 inches diameter; 16 flues, 2 inches each.
Description of engines: Worthington, duplex, high-pressure; 1⁵⁄₈ by 10 inches; plain slide-valve. Williamson, 18½ by 24 inches; steam shifting-valves. Blake compound condensing duplex; 14 by 24 inches; plain slide-valve. Air-pump—steam-cylinder, 10 inches; air-cylinder, 14 inches; 18 inches stroke.
Cost of engines and pumps: Worthington, $1,500; Williamson, $1,050; Blake, $5,500.

FLORIDA.

JACKSONVILLE:

Population: 7,650 inhabitants.
Name of corporation: Jacksonville Water-Works (municipal).
Water obtained from: Well and stream.
Water first introduced: July, 1880.

JACKSONVILLE—Continued.

Description of stand-pipe: 10 inches; cast iron; 100 feet high; in case of fire this is shut off and direct pumping is practiced.
Sizes of distributing mains: 14 to 6 inches.
Available head: 100 feet (average).
Total length of distributing mains: 8 miles.
Number of water-takers: 150.
Consumption of water: 80,000 gallons per day (exact).
First cost of water-works: $95,000.
Number of fire-plugs: 87.
Design and dimensions of pump and water-plungers: Built by Worthington, New York, in 1880; plain plungers; 6½ strokes per minute; pump-barrel, 18 by 36 inches and 16 by 24 inches.
Time pump is run: Constantly.
Description of force-main: 1,420 feet long; 14 inches diameter; 45 pounds pressure on pump.
Description of water-valves: Rubber; 6½ inches diameter; 1 inch lift.
Kind of power used: Steam.
Description of boilers: Return tubular; 16 feet long; 5 feet diameter; 64 tubes, 4 inches diameter each; fuel, wood.
Description of engines: One compound condensing, 14 by 18 inches; 24 by 18 inches; one high-pressure, 18½ by 10 inches; 6½ strokes per minute; slide-valves operated by opposite engine; four single-acting air-pumps, 12 inches diameter; 10 inches stroke; jet-condenser, 18 by 36 inches.
Cost of engines and pumps: $20,000.

ILLINOIS.

ALTON:

Population: 8,975 inhabitants.
Name of corporation: Alton Water-Works (private).
Water obtained from: Mississippi river.
Water first introduced: January, 1876.
Description of main conduit: 5 feet high by 2 feet wide; stone laid in cement; head, 3 to 30 feet.
Description of distributing reservoirs: Two tanks, elevated 50 feet above highest point of city; one 40 feet diameter, 24 feet high; the other 30 feet diameter, 16 feet high, set on trestle, making top of tanks 250 feet above pumps.
Sizes of distributing mains: 16, 10, 8, and 6 inches.
Available head: 150 to 250 feet.
Total length of distributing mains: 12 miles.
Number of water-takers; 106.
Consumption of water: 200,000 gallons per day (estimated)
First cost of water-works: $90,000.
Average annual cost of maintenance and repairs: $3,600.
Filtering appaiatus: Box filled with sponges; cleaned once a month.
Number of fire-plugs: 87.
Design and dimensions of pumps and water-plungers: Built at Indianapolis; 26 to 30 strokes per minute; pump-barrel, 12 by 30 inches. Worthington, New York, pump being put in now.

ALTON—Continued.
Time pump is run: 3½ hours per day.
Description of force-main: 1¼ mile long; head, 250 feet on pump.
Description of water-valves: Rubber.
Kind of power used: Steam.
Description of boilers: Four, 20 feet long; 48 inches diameter; 60 to 70 pounds pressure; fuel, bituminous coal.
Description of engines: Dean; 24 inches diameter; 24 inches stroke; Worthington; 18½ by 14 by 10 inches; double.
Cost of engines and pump: Dean, $5,000.

JACKSONVILLE:
Population: 10,927.
Name of corporation: Jacksonville Water-Works (municipal).
Water obtained from: Reservoir and creek.
Total area of water-shed available: Reservoir, 4 square miles; creek, 20 square miles.
Capacity of receiving reservoir: 6,000,000 gallons.
Character and dimensions of dam: 18 feet high across valley.
Cost of dam: $25,000.
Water first introduced: February, 1874.
Description of distributing reservoir: Circular; 135 feet diameter on bottom; 185 feet diameter on top; 15 feet deep; capacity, 2,500,000 gallons; situated on an eminence.
Sizes of distributing mains: 10 to 4 inches.
Available head: 86 feet (average); water-supply deficient.
Total length of distributing mains: 9 miles.
Number of water-takers: 350.
Consumption of water: 212,000 gallons per day (exact).
First cost of water-works: $150,000.
Average annual cost of maintenance and repairs: $3,500 to $4,000.
Number of fire-plugs: 75.
Design and dimensions of pump and water-plungers: Built by Worthington, New York, in 1878; two plain plungers, 15 inches diameter; 16 inches stroke; 16 to 18 strokes per minute; pump-barrel about 31 inches diameter.
Time pump is run: About 18 hours per day.
Time spent in repairs: None.
Description of force-main: 2½ miles long; 10 inches diameter; head, 120 to 134.85 feet on pump.
Description of water-valves: Soft rubber, 1 inch thick; 8 inches diameter; ¼ inch lift.
Kind of power used: Steam.
Description of boilers: Two tubular; 16 feet long; 60 inches diameter; 48 tubes, 4 inches diameter; 60 pounds pressure; fuel, bituminous coal.
Description of engine: Non-condensing, Worthington duplex; common "D"-valve, operated by opposite rocker-shaft.
Cost of engine and pump: $4,650.
Remarks: Water somewhat unpleasant in hot weather.

MORRISON:
Population: 1,951 inhabitants.
Style of corporation: Municipal.
Water obtained from: Artesian well.
Water first introduced: In 1873.
Description of distributing reservoir: Wooden; built 10 feet above ground; capacity, 90,000 gallons.
Size of distributing mains: 6 inches.
Available head: 65 feet (average).
Length of distributing mains: 660 feet.
Number of water-takers: 40.
Consumption of water: 30,000 gallons per day (estimated).
First cost of water-works: $12,000.
Average annual cost of maintenance and repairs: $1,500.
Number of fire-plugs: 13.
Design and dimensions of pump and water-plunger: Blake No. 8 fire-pump, New York; plain piston-plunger, 7 inches diameter; 12 inches stroke; 40 to 150 strokes per minute; pump-barrel, 7 inches diameter.
Time pump is run: 10 hours per day.
Time spent in repairs: 5 hours per year.

MORRISON—Continued.
Description of water-valves: Puppet.
Kind of power used: Steam.
Description of boilers: Tubular; 12 feet long; 42 inches diameter; 36 tubes, 3 inches diameter; fuel, soft coal.
Description of engine: Simple; cylinder, 12 inches diameter; 12 inches stroke; water-cylinder, 7 inches diameter.
Cost of engine and pump: $700.

SPRINGFIELD:
Population: 19,743 inhabitants.
Name of corporation: Springfield Water-Works (municipal).
Water obtained from: Sangamon river.
Water first introduced: In 1868.
Description of distributing reservoir: Square embankment with rounded corners; 275 feet square at top, 23¾ feet deep; inner slope, 1½ to 1; outer, 2 to 1; puddle facing, 18 inches; stone riprap, 5 inches; bottom, 2 feet of fine clay and 2½ feet of concrete; capacity, 4,000,000 gallons; stand-pipe in center, 75 feet high, 30 inches diameter; wrought iron.
Sizes of distributing mains: 15, 10, 6, and 4 inches.
Total length of distributing mains: 20 miles.
Number of water-takers: 700.
Consumption of water: 1,500,000 to 2,000,000 gallons per day.
First cost of water-works: $450,000.
Average annual cost of maintenance and repairs: $12,000 to $15,000.
Number of fire-plugs: 91.
Design and dimensions of pump and fire-plungers: Built by Worthington, New York, in 1876; plain plungers, 18 inches diameter; 36 inches stroke; 28 strokes per minute.
Time pump is run: 17 hours per day.
Description of force-main: 3¼ miles long; 15 inches diameter; cast iron.
Description of water-valves: Rubber disk; 6 inches diameter; 1½ inch lift.
Kind of power used: Steam.
Description of boilers: Four tubular, 16 feet long, 5 feet diameter; two with 52 tubes, 4 inches diameter; two with 48 tubes, 3½ inches diameter; 60 pounds pressure; fuel used, bituminous coal.
Description of engine: Non-condensing; 29 inches diameter, 36 inches stroke, 28 strokes per minute; slide-valves.
Cost of engine and pump: $13,200 without boilers.

INDIANA.

NEW CARLISLE:
Population: 530 inhabitants.
Style of corporation: Municipal.
Water obtained from: Well.
Water first introduced: In 1879.
Description of distributing reservoir: Wooden tank; 40 feet above ground-level; 103 feet from suction at pump-house.
Sizes of distributing mains: 6 and 4 inches.
Available head: 36 feet (average).
Total length of distributing mains: 7,000 feet.
Consumption of water; 8,000 gallons per day (estimated).
First cost of water-works: $7,000.
Average annual cost of maintenance and repairs: $302 95.
Number of fire-plugs: 13.
Design and dimensions of pump and water-plungers: Built by Worthington, New York; bucket-plungers, 7 inches diameter; pump-barrels, 7 inches diameter.
Time pump is run: One hour per day.
Time spent in repairs: None.
Description of force-main: 6 inches diameter; 40 pounds pressure on pump.
Description of water-valves: Rubber; 3 inches diameter; ¼ inch lift.
Kind of power used: Steam.
Description of boiler: 60 pounds pressure.
Description of engine: Non-condensing, 14 by 10 inches; slide-valves.

PERU:

Population: 5,280 inhabitants.
Name of corporation: Peru Water-Works (municipal).
Water obtained from: Wabash river.
Total area of water-shed available: 250 square miles.
Cost of dam: $11,811 52.
Water first introduced: In March, 1879.
Description of main conduit: 370 feet long; 20 inches diameter; iron.
Description of distributing reservoir: Square embankment, 20 feet high; water-level, 16 feet above bottom; embankments all puddled 1 foot thick, and with brick laid without mortar.
Sizes of distributing mains: 16, 12, 10, 8, 6, and 4 inches.
Available head: About 93 feet (average).
Total length of distributing mains: 11 miles and 4,454 feet.
Number of water-takers: 160.
First cost of water-works: $109,549 93.
Average annual cost of maintenance and repairs: About $5,000.
Filtering apparatus: Cleaned once a year.
Number of fire-plugs: 101; various designs.
Design of pump and water-plungers: Built by Worthington, New York, in 1879.
Kind of power used: Steam.
Description of boilers: Nashua steel return-tubular; 16 feet long; 5 feet 4 inches diameter; 65 tubes, 4 inches diameter each; fuel, Indiana block coal.
Cost of engine and pump: $17,902 85.
Duty of engine: 50,000,000 foot-pounds guaranteed.

IOWA.

ANAMOSA:

Population: 2,083 inhabitants.
Name of corporation: Anamosa Water-Works Company (private).
Water obtained from: Wapsipinicon river.
Cost of dam: $600.
Water first introduced: August, 1875.
Description of distributing reservoir: Built with curved sides and square ends; 60 feet long; 14½ feet wide; 15½ feet deep.
Size of distributing mains: 60 inches.
Available head: 75 pounds (average).
Total length of distributing mains: 2 miles.
Number of water-takers: 300.
Consumption of water: 25,000 gallons per day (estimated).
First cost of water-works: $15,000.
Average annual cost of maintenance and repairs: $800.
Number of fire-plugs: 7.
Design and dimensions of pump and water-plungers: Built by Cope & Maxwell, Hamilton, Ohio; bucket-plungers; 10 inches diameter; 36 inches stroke; 25 strokes per minute; pump-barrel, 10 inches diameter.
Time pump is run: 18 hours per week.
Time spent in repairs: 30 hours per year.
Description of force-main: ¼ mile long; 6 inches diameter; 75 pounds pressure on pump.
Description of water-valves: Leather; 10 inches diameter.
Kind of power used: Steam.
Description of boiler: Tubular; 40 horse-power; fuel, wood.
Description of engine: Simple; cylinder, 16 inches diameter 34 inches stroke; 25 strokes per minute; slide-valves.
Cost of engine and pump: $2,000.

LYON:

Population: 4,095 inhabitants.
Name of corporation: Lyons Water-Works Company (private).
Water obtained from: Mississippi river.
Capacity of reservoir: 500,000 gallons.
Cost of dam: $2,400.
Water first introduced: March, 1875.
Description of main conduit: 16 inches diameter; cast iron.

LYON—Continued.

Description of distributing reservoir: An excavation on high ground, with massive banking around it; bottom and sides, puddled clay, 18 inches thick; one course of brick laid in water-lime over a rubble and water-lime coating over puddled clay.
Sizes of distributing mains: 12 to 2 inches.
Available head: 110 feet (average).
Total length of distributing mains: 3 miles.
Number of water-takers: 120.
Consumption of water: 150,000 gallons (estimated).
First cost of water-works: $45,000.
Average annual cost of maintenance and repairs: $1,047.
Number of fire-plugs: 37.
Design and dimensions of pumps and water-plungers: Built by Knowles, Warren, Massachusetts, in 1875; plain plungers, 3 feet 10 inches, 25 strokes per minute; pump-barrel, 30 inches diameter. Built by Cope & Maxwell, Detroit, Michigan, in 1874; plain plunger, 12 inches; 40 strokes per minute; pump-barrel, 24 inches diameter.
Time pumps are run: 8 hours; 3 days per week.
Time spent in repairs: 60 hours per year.
Description of force-main: 1,800 feet long; 16 inches diameter; 80 to 130 pounds pressure on pumps.
Description of water-valves: Ludlow.
Kind of power used: Steam.
Description of boilers: Two 3-flue; 90 to 100 pounds pressure.
Description of engine: Simple; cylinder, 24 inches diameter; 24 inches stroke; Ludlow valves.
Cost of engine and pumps: $7,500.
Remarks: During low water the water can not be used for domestic purposes.

OTTUMWA:

Population: 9,004 inhabitants.
Name of corporation: Ottumwa Water-Works (private).
Water obtained from: Des Moines river.
Character and dimensions of dams: Two; stone and wood; 350 feet long; 12 feet deep.
Water first introduced: In 1878.
Description of main conduit: 20 inches diameter; iron.
Discharging capacity: 3,000,000 gallons per day.
Description of distributing reservoir: Built on high elevation.
Sizes of distributing mains: 16 to 4 inches.
Available head: 90 pounds (average).
Total length of distributing mains: 8 miles.
Number of water-takers: 340.
Consumption of water: 75 gallons per head per day (estimated).
Filtering apparatus: Gallery divided into compartments 30 feet square; charcoal; cleaned once a month.
Number of fire-plugs: 76.
Design and dimensions of pumps and water-plungers: Flanders, Vergennes, Vermont; Knowles' steam-pump; four plain plungers; 12 to 30 strokes per minute; pump-barrels, 10, 12, and 14 inches.
Time pumps are run: Constantly.
Description of force-main: 1 mile long; 16 inches diameter; head, 220 feet on pumps.
Description of water-valves: 10 and 12 inches diameter.
Kind of power used: Steam and water.
Description of water-wheels: Eclipse turbine, 72 inches diameter; American turbine, 66 inches diameter; 8 to 10 feet head; about 60 gallons of water required to lift 1 gallon to reservoir.
Description of boiler: Tubular; 70 pounds pressure.
Description of engine: 30 strokes per minute.
Remarks: River is always muddy when the water is high; a slaughter-house above the works imparts a good deal of filth to water.

KENTUCKY.

BOWLING GREEN:

Population: 5,114 inhabitants.
Name of corporation: Bowling Green Water-Works (municipal).
Water obtained from: Barren river.
Water first introduced: In 1868.
Discharging capacity of conduit: Head, 237 feet (average).
Description of distributing reservoir: Oval in shape; on elevation 237 feet above town; capacity, 1,000,000 gallons.
Sizes of distributing mains: 8, 6, and 4 inches.
Available head: 65 pounds (average).
Total length of distributing mains: 7 miles.
Number of water-takers: 500.
Consumption of water: 300,000 gallons per day, or 60 gallons per head (estimated).
First cost of water-works: $100,000.
Number of fire-plugs: 45.
Design and dimensions of pump and water-plungers: Designed by C. Hennary; built by Dennis Long & Co., Louisville, Kentucky, in 1868; one *plain double-acting* plunger; 12 inches diameter; 30 inches stroke; 27 strokes per minute; 12 inches diameter pump-barrel.
Time pump is run: 12 hours per day.
Description of force-main: 5,800 feet long; 8 inches diameter; 100 pounds pressure on pumps.
Description of water-valves: Leather.
Kind of power used: Steam.
Description of boilers: Two flue, 20 feet long, 40 inches diameter; one tubular, 14 feet long, 60 inches diameter, 81 flues; fuel, Green River coal.
Description of engine: Simple; 16 inches diameter; 30 inches stroke; 27 strokes per minute.
Cost of pump and engine: $14,000.

MASSACHUSETTS.

ATTLEBOROUGH:

Population: 11,111 inhabitants.
Name of corporation: Attleborough Water-Supply District (municipal).
Water obtained from: Springs.
Water first introduced: In 1874.
Description of distributing reservoir: Wrought iron; 40 feet high; 30 feet deep; inclosed in brick and covered; capacity, about 200,000 gallons.
Sizes of distributing mains: 8, 6, and 4 inches.
Available head: 26 to 30 pounds.
Total length of distributing mains: 6 miles.
Number of water-takers: 500.
Consumption of water: 50 gallons per head per day (estimated).
First cost of water-works: $60,000.
Number of fire-plugs: 70.
Design and dimensions of pumps and water-plungers: One Blake, Boston; one Worthington, New York, 1874; plain plungers; diameters, 18 and 14 inches.
Time pumps are run: 6 to 8 hours per day.
Time spent in repairs: About 24 hours per year.
Description of force-main: ¾ mile long; 32 pounds pressure on pumps.
Kind of power used: Steam.
Description of boilers: Power rented; fuel, anthracite coal.
Cost of engine and pumps: $1,600.

LAWRENCE:

Population: 39,151 inhabitants.
Style of corporation: Municipal.
Water obtained from: Merrimack river.
Total area of water-shed available: 4,136 square miles.
Water first introduced: December, 1875.
Sizes of distributing mains: 30, 24, 20, 16, 12, 10, 8, and 6 inches.
Available head: 160 feet (average).

LAWRENCE—Continued.

Total length of distributing mains: 42.17 miles.
Number of water-takers: 8,241.
Consumption of water: 681,259,174 gallons in 1880.
First cost of water-works: $1,200,000.
Average annual cost of maintenance and repairs: $15,000.
Filtering apparatus: Gallery, 300 feet long; 8 feet wide; 8 feet high; 15 feet below crest of Essex dam; gravel and sand.
Number of fire-plugs: 464.
Design and dimensions of pump and water-plungers: E. D. Leavitt pump, built by I. P. Morris & Co., Port Richmond Iron-works, Philadelphia, Pennsylvania, in 1875; two bucket-plungers; 18¼ inches diameter; 28 inches stroke; 14.64 strokes per minute; pump-barrel, 26¼ inches diameter, 8 feet stroke.
Time pump is run: 11 hours 53 minutes per day (average); 305 days per year.
Time spent in repairs; About 40 hours per year.
Description of force-main: 5,000 feet long; 30 inches diameter; head, 180 feet on pump.
Description of water-valves: Double beat; cast-iron case inclosing rubber ring; 16½ inches diameter; ¾ inch lift.
Kind of power used: Steam.
Description of boilers: Two fire-box tubular; 25 feet 5½ inches long; 5 feet 3 inches diameter; 80 tubes, 3 inches diameter each; 90 pounds pressure; evaporation, 11.49 pounds of water to 1 pound of coal.
Description of engine: Compound; high-pressure cylinder, 18 inches diameter; low-pressure cylinder, 38 inches diameter; 8 feet stroke; grid-iron slide-valves worked by revolving "cams." Double-acting air-pump; 15 inches diameter; 28 inches stroke; internal jet-condenser.
Cost of engine and pump: $120,000.
Duty of engine: 102,224,637 foot-pounds in 1880, daily; guaranteed for 95,000,000 foot-pounds.
Remarks: The advantage in pumping to mains is its prompt availability in case repairs are needed in other systems.

PLYMOUTH:

Population: 7,093 inhabitants.
Name of corporation: Plymouth Water-Works (municipal).
Water obtained from: (1) Great, and (2) Little South, ponds; (3) Boot pond; (4) a small lake.
Area of reservoirs: No. 1, 318 acres; No. 2, 54 acres; No. 3, 74 acres; No. 4, 18 acres; all natural reservoirs with artificial connections; no dam required.
Cost of reservoir improvements: $3,000.
Water first introduced: In 1855.
Description of main conduit: 60 feet, 20 inches; 7,300 feet, 10 inches; and 9,200 feet, 10 inches; wrought-iron pipe, coated and lined with cement.
Discharging capacity: 27,000 gallons per hour; head, 16 feet (average).
Description of distributing reservoir: Oblong; 116 by 200 feet; 16 feet deep; slopes, 1½ to 1; bottom and sides clay puddled 1½ feet thick; coat of gravel and sand, 2 feet thick, over which is stone lining, 108 feet above low-water mark; capacity, 1,800,000 gallons.
Sizes of distributing mains: 8 to 2 inches.
Available head: 50 to 90 feet; water-supply deficient for dwellings; relying on pumps.
Total length of distributing mains: 102,291 feet.
Number of water-takers: 1,200.
First cost of water-works: $102,000.
Average annual cost of maintenance and repairs: $3,800.
Filtering apparatus: Only a wire-screen; cleaned once a month.
Number of fire-plugs: 62.
Design and dimensions of pump and water-plungers: Built by H. R. Worthington, New York, in 1879; two plain plungers; 14 inches diameter; 18 inches stroke; 42 strokes per minute; pump-barrel, 20 inches diameter.

PLYMOUTH—Continued.

Time pump is run: 12 hours per day.
Description of force-main: 9,200 feet long; 10 inches diameter; head, 60 feet on pump.
Description of water-valves: Rubber; 6 inches diameter; 1¼ inch lift.
Kind of power used: Steam.
Description of boilers: Return tubular; 14 feet long; 4 feet diameter; 30 pounds pressure; fuel, anthracite coal.
Description of engine: Compound condensing; duplex; high-pressure cylinder, 14 inches diameter; low-pressure cylinder, 24½ inches diameter; 18 inches stroke; 84 strokes per minute; slide-valves operated by piston; four bucket air-pumps, 9 inches diameter.
Cost of engine and pump: $7,000.
Duty of engine: 62,424,756 foot-pounds, daily; 50,000,000 foot-pounds guaranteed.
Remarks: Water has a fishy taste and smell sometimes, but this never lasts more than two or three weeks.

WEST NEWTON:

Population: (Population included in Newton.)
Style of corporation: Municipal.
Water obtained from: Charles river.
Area and capacity of reservoir: 126,000 square feet; 1,500,000 gallons.
Water first introduced: In 1876.
Sizes of distributing mains: 16, 12, 8, 6, and 4 inches.
Available head: 60 to 80 pounds.
Total length of distributing mains: 61 miles.
Number of water-takers: 2,261.
Consumption of water: 452,000 gallons per day (estimated).
First cost of water-works: $766,157 22.
Average annual cost of maintenance and repairs: $9,500.
Filtering apparatus: Gallery; gravel; cleaned once a year.
Number of fire-plugs: 324.
Design and dimensions of pump and water-plungers: Built by H. R. Worthington, New York, in 1876; two plain plungers, 21 and 21½ inches diameter; 50 inches stroke; 10 strokes per minute; pump-barrels, 3 feet 4 inches diameter; 10 feet 2 inches long.
Time pump is run: 30 hours per week.
Description of force-main: 21,120 feet long; 20 inches diameter; head, 201.75 feet on pump.
Description of water-valves: Rubber; 9½ inches diameter; 1¼ inch lift.
Kind of power used: Steam.
Description of boilers: Tubular; 20 feet long; 5 feet 5 inches diameter; 50 pounds pressure; evaporation, 8 pounds of water to 1 pound of coal; fuel, hard coal.
Description of engine: Compound condensing; high-pressure cylinder, 30 inches diameter; low-pressure cylinder, 50½ inches diameter; 50 inches stroke; 20 strokes per minute; slide-balance piston-valves by rocker-arm; air-pumps, 2 feet 8 inches diameter; 2 feet stroke; jet-condenser.
Cost of engine and pump: $48,000.
Duty of engine: 63,245,116.1 foot-pounds, daily; 65,000,000 foot-pounds guaranteed.

WOBURN:

Population: 10,931 inhabitants.
Name of corporation: Woburn Water-Works (municipal.)
Total area of water-shed available: 4,760 acres.
Cost of dam: About $50,000.
Water first introduced: September, 1873.
Description of distributing reservoir: Capacity, 5,000,000 gallons; 182 feet above engine-house floor.
Sizes of distributing mains: 14, 12, 10, 8, 6, and 4 inches.
Available head: 65 pounds (average).
Total length of distributing mains: About 37 miles.
Number of water-takers: 2,000.
Consumption of water: About 800,000 gallons, or 75 gallons per head per day (estimated).

WOBURN—Continued.

First cost of water-works: $450,000.
Average annual cost of maintenance and repairs: $8,000.
Filtering apparatus: Gallery, 12 by 82 feet; 5 feet deep (average); connected with pump-wells, 20 feet distant, by 24-inch conduit; loose stone wall; no cleaning.
Number of fire-plugs: 268.
Design and dimensions of pumps and water-plungers: One built by Worthington, New York, in 1873; two plain plungers, 15 inches diameter; 24 inches stroke; 40 strokes per minute; pump-barrel, 21 inches diameter; 4 feet 2 inches long; one built by G. F. Blake, Boston, in 1880.
Time pumps are run: 313 days per year (average).
Time spent in repairs: About 500 hours per year.
Description of force-main: 1,000 feet long; 14 inches diameter; 90 pounds pressure on pumps (average).
Description of water-valves: Rubber; 6-inch size; ⅝ inch lift.
Kind of power used: Steam.
Description of boilers: 16 feet long; 5 feet diameter; 88 tubes, 3 inches diameter; 47 pounds pressure; evaporation, 8¼ pounds of water to 1 pound of coal; fuel, Cumberland coal.
Description of engine: Duplex, compound, condensing; high-pressure cylinder, 19½ inches diameter; low-pressure cylinder, 33⅝ inches diameter; 24 inches stroke; 80 strokes per minute; D-valve operated by rocker-shaft and crank; jet-condenser.
Cost of engine and pumps: About $22,000
Duty of engine: 50,000,000 foot-pounds, daily; 55,000,000 foot-pounds guaranteed.

MICHIGAN.

GRAND RAPIDS:

Population: 32,016 inhabitants.
Name of corporation: City Water-Works (municipal).
Water obtained from: Two creeks.
Total area of water-shed available: One, 6 square miles; and one 11.5 square miles.
Cost of reservoirs and dam: Distributing reservoir, $54,066 26; settling reservoir, $12,064 35; dam, $50.
Water first introduced: In 1874.
Description of main conduit: 1,993 feet long; 20 inches diameter; iron; head, 20 feet (average).
Description of distributing reservoir: Circular; 196 feet diameter at bottom, 271 feet diameter at top, 25 feet deep; depth of water, 20 feet (average); embankment, earth with puddle walls, 8 feet thick, 21½ feet high in center; capacity, 6,000,000 gallons.
Sizes of distributing mains: 20, 16, 14, 12, 10, 8, 6, and 4 inches.
Available head: 150 feet (average).
Total length of distributing mains: 22.28 miles.
Number of water-takers: 1,200.
Consumption of water: 1,107,424 gallons per day (estimated).
First cost of water-works: $404,296 01.
Average annual cost of maintenance and repairs: $9,000.
Number of fire-plugs: 235; various designs.
Design and dimensions of pump and water-plungers: Turner pump, built by Buteworth & Lowe in 1878; piston-plunger, 15 inches diameter, 15 to 20 strokes per minute; pump-barrel, 14½ by 15 inches.
Description of force-main: 2,578 feet long; 16 inches diameter; head, 150 feet on pump.
Description of water-valves: Rubber-faced; 8 or 10 inches diameter.
Kind of power used: Steam.
Kind of fuel used: Wood.
Description of engine: Horizontal; direct-acting condensing; cylinder, 33 inches diameter; 6 feet stroke; 15 to 20 strokes per minute; balanced puppet-valves; condenser, 3½ feet diameter, 15 feet high.
Cost of engine and pump: $36,534 90.

MISSOURI.

HANNIBAL:

Population: 11,074 inhabitants.
Name of corporation: Hannibal Water Company (private).
Water obtained from: Mississippi river.
Water first introduced: February, 1880.
Description of distributing reservoir: Oval in shape; one-fourth of depth excavated, rest built up; clay, puddled in layers; lined with clay-puddle; bottom and inside slopes paved with rubble-stones; capacity, 1,500,000 gallons.
Sizes of distributing mains: 14 to 6 inches.
Available head: 210 feet (average).
Total length of distributing mains: About 11 miles.
Number of water-takers: 500.
Consumption of water: 130,000 gallons per day (exact).
First cost of water-works: $100,000.
Filtering apparatus: Well; 40 feet deep; 10 feet diameter; 2 layers of gravel and 3 layers sheep's-wool sponges; cleaned 3 or 4 times per year; settling-well, 40 feet deep; 35 feet diameter.
Number of fire-plugs: 75.
Design and dimensions of pump and water-plungers: Built by the Blake Manufacturing Company, Boston, Massachusetts, in 1879; 2 plain plungers; 15 inches diameter; 24 inches stroke; 40 to 50 strokes per minute; pump-barrel, 15 inches diameter.
Time pump is run: 8 hours per day (average).
Description of force-main: 1,500 feet long; 12 inches diameter; head, 220 feet, or 90 pounds pressure on pump.
Description of water-valves: Rubber; 4 inches diameter; ¾ inch lift.
Kind of power used: Steam.
Description of boilers: Tubular; 12 feet long; 64 inches diameter; 3-inch tubes; 60 pounds pressure; fuel, native (Missouri) coal.
Description of engine: Non-condensing simple; cylinder, 24 by 24 inches; 40 to 50 strokes per minute; lever gate-valve.
Cost of engine and pump: $7,000.

SEDALIA:

Population: 9,561 inhabitants.
Style of corporation: Municipal.
Water obtained from: Flat creek.
Character and dimensions of dam: Drop dam; 102 feet long; 4 feet high; stone piers.
Cost of dam: $150,000.
Water first introduced: In 1872.
Description of main conduit: 3 miles long; 12 inches diameter; cast iron.
Description of distributing reservoir: Tank, 30 by 40 feet, placed upon trestle-work 40 feet high; total elevation, 60 feet.
Size of distributing mains: 12 inches.
Available head: 60 feet (average).
Total length of distributing mains: About 18 miles.
Number of water-takers: About 400.
Consumption of water: 25 gallons per head per day (estimated).
First cost of water-works: About $125,000.
Average annual cost of maintenance and repairs: About $7,000.
Number of fire-plugs: 32.
Design and dimensions of pump and water-plungers: Holly; 15 strokes per minute; pump-barrel, 12 inches diameter; 85 pounds pressure.
Time pump is run: 8 hours per day.
Kind of power used: Steam.
Description of engine: Condensing compound; 15 strokes per minute.

NEW JERSEY.

ELIZABETH:

Population: 28,229 inhabitants.
Name of corportion: The Elizabeth Town Water Company (private).
Water obtained from: Elizabeth river.

ELIZABETH—Continued.

Total area of water-shed available: About 40 square miles.
Capacity of reservoir: 100,000,000 gallons.
Character and dimensions of dam: 110 feet long; 12 feet high.
Cost of dam: $200,000; improvements, $75,000.
Water first introduced: March, 1854.
Description of main conduit: To basin, 1 mile long; 24 inches diameter; wrought iron, lined with cement.
Discharging capacity: About 10,000,000 gallons; head 12 feet (average).
Description of distributing reservoir: About 65 feet above tide-water; capacity, 15,000,000 gallons.
Sizes of distributing mains: 24, 20, 16, 12, 10, 6, 4, and 2 inches.
Available head: 60 feet (average); water-supply deficient.
Total length of distributing mains: 40 miles.
Number of water-takers: 2,000.
Consumption of water: 80 gallons per head per day (estimated).
First cost of water-works: $250,000.
Average annual cost of maintenance and repairs: $45,000.
Filtering apparatus: In pumping basin; 150 feet long; 8 feet wide; 8 feet deep; alternate layers of gravel, sand, and charcoal; cleaned once in two years.
Number of fire-plugs: 200.
Design and dimensions of pumps and water-plungers: Built by Hewet A. Phillips and L. B. Battus, Newark, 1854, Elizabeth, 1874; plain plungers, packed with leather, 12, 14, and 20 inches diameter; 48 inches stroke; two, 30 strokes per minute, and one, 16 strokes per minute; pump-barrel, 12, 14, and 20 inches diameter.
Time pumps are run: 15 hours per day.
Time spent in repairs: 168 hours per year.
Description of force-main: 24 inches diameter; 25 pounds pressure on pumps.
Description of water-valves: Circular, 6 inches diameter; square strips of rubber in one; rings of rubber in one; conical strips on one; about ¼ inch lift.
Kind of power used: Steam and water.
Description of water-wheel: One turbine, 54 inches diameter; 12 feet head; 90 revolutions per minute; 17 gallons of water required to lift 1 gallon to reservoir.
Description of boilers: Four, horizontal tubular; 16 feet long; 4½ feet diameter; evaporation, 10 pounds of water to 1 pound of coal; fuel, No. 2 chestnut coal.
Description of engines: Condensing; one, 18 inches diameter; 4 feet stroke; one, 24 inches diameter; 4 feet stroke; 30 strokes per minute; D-valve, with cut-off at ¼ inch stroke; air-pumps, single-acting, induction butterfly; eduction in the piston; jet-condenser.
Cost of engines and pumps: $10,000.

NEW YORK.

BUFFALO:

Population: 155,134 inhabitants.
Name of corporation: Buffalo Water-Works (municipal).
Water obtained from: Niagara river.
Water first introduced: In 1851.
Description of distributing reservoir: Embankment of earth, 600 by 300 feet; 21 feet deep; slopes, inner, 1 to 1—outer, 1½ to 1; width at top, 13 feet; puddle-faced to depth of 12 inches; ripraped with brick.
Sizes of distributing mains: 16, 12, 10, 8, 6, and 4 inches.
Total length of distributing mains: 103 miles.
Available head: Holly system, 40 pounds pressure; head from reservoir, 90 feet (average).
Number of water-takers: 9,000.
Consumption of water: 18,000,000 gallons per day.
First cost of water-works: $705,000.
Average annual cost of maintenance and repairs: $58,255.
Number of fire-plugs: 1,118.

BUFFALO—Continued.

Design and dimensions of pumps and water-plungers: Two sets built by Holly Manufacturing Company, Lockport, New York, in 1868 and 1877; plain piston-plungers, half of them 14 inches diameter, 24 inches stroke—the rest, 15½ inches diameter, 33½ inches stroke; 36 to 40 strokes per minute. Two Worthington, New York, 1874–'77; plain plungers; 4 feet stroke; 40 strokes per minute. One built by Sheppard, Buffalo, New York, in 1867; plain piston-plunger; 32½ inches diameter; 10 feet stroke; 16 strokes per minute.

Time pumps are run: Holly, constantly; Worthington, both sets, total, 418 days; Sheppard, seldom.

Time spent in repairs: Variable.

Description of force-main: 3,000 feet long; 30 and 36 inches diameter; 42 pounds pressure on Holly pumps, 30 pounds pressure on others.

Kind of power used: Steam.

Description of boilers: 3 Worthington multitubular, 18 feet long, 5 feet diameter, 58 4-inch tubes, 35 pounds pressure. Four marine, 16 feet long, 8 feet diameter, 120 4-inch tubes; one 14 feet long, 9 feet diameter, 130 3-inch tubes. Fuel, anthracite coal.

Description of engines: Sheppard's—condensing cylinder, 65 inches diameter; 10 feet stroke; 16 strokes per minute; double-beat valves by cams and plug-rods; air-pump, 32½ inches by 4 feet; jet-condenser, 4 by 4 feet. Holly—non-condensing or compound cylinders, 14 and 15½ inches diameter; 24 and 32½ inches strokes; 36 to 40 strokes per minute; condenser, 5 by 18 inches; air-pumps, 20 by 18 inches stroke. Worthington—compound; 40 strokes per minute; jet-condenser, 3 by 6 feet; air-pumps, 24 by 24 inches and 18 by 24 inches.

Cost of engines and pumps. Sheppard, $28,000; Holly, $46,500; Worthington, $91,000.

Duty of engines: Sheppard, 45,000,000 foot-pounds, daily; Holly, 85,000,000 foot-pounds, daily; Worthington, 45,000,000 foot-pounds, daily.

Remarks: Pumping used because no site sufficiently elevated for reservoir is available.

ROME:

Population: 12,194 inhabitants.

Name of corporation: Rome Water Company (municipal).

Water obtained from: Mohawk river.

Capacity of reservoir: 10,000,000 gallons.

Cost of dam: $20,000.

Water first introduced: In 1872.

Sizes of distributing mains: 16, 12, 10, 8, and 4 inches.

Available head: 25 pounds (average).

Total length of distributing mains: 16 miles.

Number of water-takers: 600.

Consumption of water: 900,000 gallons per day (estimated).

First cost of water-works: $160,000.

Average annual cost of maintenance and repairs: $2,500.

Number of fire-plugs: 125.

Design and dimensions of pump and water-plungers: Built by Watertown Steam-Engine Company, Watertown, New York; plain plungers, 12 by 24 inches; 1 foot diameter; 24 strokes per minute.

Time pump is run: 14 hours per day.

Description of force-main: Head, 65 feet; 20 pounds pressure on pump.

Description of water-valves: Double-seated brass; size, 12 inches; 1¼ inch lift.

Kind of power used: Water.

Description of water-wheels: Two turbines, 6 feet diameter; made by Helmer & Harris, Rome, New York; 8 feet head; 16 revolutions per minute.

PENNSYLVANIA.

BETHLEHEM:

Population: 5,193 inhabitants.

Name of corporation: Bethlehem Borough Water-Works (municipal).

BETHLEHEM—Continued.

Water obtained from: Spring.

Cost of dam: $20,300.

Description of main conduit: 16,000 feet long; 8, 6, 4, and 3 inches diameter; iron.

Discharging capacity: 777,700 gallons per day.

Description of distributing reservoir: Capacity of tank, 167,000 gallons; filled from mains.

Sizes of distributing mains: 8, 6, 4, and 3 inches.

Available head: 149 feet (average); water-supply deficient.

Total length of distributing mains: 16,000 feet.

Consumption of water: 167,000 gallons per day (estimated).

First cost of water-works: $20,300.

Average annual cost of maintenance and repairs: $1,500.

Design and dimensions of pumps and water-plungers: Cameron patent, New York, 1874; plain plungers; one steam, 12 inches diameter, 36 inches stroke, 15 strokes per minute; one water, 48 inches stroke, 5½-inch plunger, 10 strokes per minute; pump-barrel, 12 inches diameter.

Time pumps are run: Water, constantly; steam, 6 hours per day.

Kind of power used: Steam and water.

Description of water-wheel: One undershot; 8 feet diameter; 20 feet long; 22 inches head; 10 revolutions per minute.

Description of boilers: 35 feet long; 3 feet diameter; 40 pounds pressure; fuel, coal screenings.

Description of engine: Non-condensing; cylinder, 24 inches diameter; 36 inches stroke; 12 strokes per minute; slide-valves self-operated.

Cost of engine and pumps: $6,000.

Remarks: Water is fresh from the spring; pressure is good.

BLOOMSBURG:

Population: 3,702 inhabitants.

Name of corporation: The Bloomsburg Water Company (private).

Water obtained from: Fishing creek.

Cost of reservoir: $6,000.

Water first introduced: In September, 1880.

Description of distributing reservoir: Built by excavation and embankment; lined with clay and paved with brick; 82 feet 6 inches square at bottom; 127 feet 6 inches square at top; capacity, 1,000,000 gallons.

Sizes of distributing mains: 10, 8, 6, and 4 inches.

Available head: About 150 feet (average).

Total length of distributing mains: 4½ miles.

Number of water-takers: 94.

Consumption of water: 260 gallons (estimated).

First cost of water-works: $36,000.

Number of fire-plugs: 40.

Design and dimensions of pumps and water-plungers: Berkenbine pumps; built by Camden Iron Works; plain plunger; one for each; 6½ inches diameter; 20 inches stroke; 50 to 60 strokes per minute; pump-barrel, 6½ to 20 inches.

Time pumps are run: 2 hours per day.

Description of force-main: 1,050 feet long; 8 inches diameter; 80 pounds pressure on pumps.

Description of water-valves: Berkenbine, double-beat, water-cushioned; ¾ inch lift.

Kind of power used: Steam.

Description of boilers: Two upright tubular; 6 feet long; 5 feet diameter; fire-box, 4 feet high; 157 2-inch flues.

Description of engine: High-pressure; cylinder, 12 inches diameter; 20 inches stroke; 50 to 60 strokes per minute; slide-valves by rock-shaft.

Cost of engine and pumps: $2,300.

Remarks: The advantage and disadvantage of direct pumping are that as a fire protection it is a great success, but is not so for ordinary consumers.

CHAMBERSBURG:

Population: 6,877 inhabitants.

Name of corporation: City Water-Works (municipal).

Water obtained from: Mountain stream.

CHAMBERSBURG—Continued.
Capacity of reservoir: 110,000 gallons.
Cost of dam: $55,000.
Water first introduced: July, 1876.
Description of distributing reservoir: Built on heavy slate, clay puddled, and lined with brick laid in sand; 100 feet above center of town.
Sizes of distributing mains: 10, 8, 6, and 4 inches.
Available head: 100 feet or 40 pounds (average).
Total length of distributing mains: 7 miles.
Number of water-takers: 450.
Consumption of water: 6 gallons per head per day (estimated).
First cost of water-works: $55,000.
Average annual cost of maintenance and repairs: $150.
Number of fire-plugs: 60.
Design and dimensions of pump and water-plungers: H. M. Berkenbine pump, Lebanon, Pennsylvania; built by Mount Wisner Manufacturing Company; one plain plunger, 14 inches diameter; 36 inches stroke; 35 strokes per minute; pump-barrel, 14 by 36 inches.
Description of force-main: 2,000 feet long; 48 pounds pressure on pump.
Description of water-valves: Cast iron; size, 12 inches; 2 inches lift.
Kind of power used: Steam.
Description of boilers: Flue; 14 feet long; 60 inches diameter; 60 pounds pressure; fuel, bituminous coal.
Description of engine: Simple; cylinder, 16 inches diameter; 30 inches stroke; 35 strokes per minute; plain slide-valves, link motion; air-chamber, 18 by 48 inches.
Remarks: The advantage of direct pumping is manifest in *case of fire, as there are no engines in town.—Water good*, except after heavy rains.

MEDIA:
Population: 1,919 inhabitants.
Style of corporation Municipal.
Water obtained from: Ridley creek.
Total area of water-shed available: About 25 square miles.
Capacity of reservoir: 1,300,000 gallons.
Character and dimensions of dam: Built of stone, filled in back with gravel; 6 feet high; 120 feet long.
Cost of dam: $14,000.
Water first introduced: In October, 1872.
Description of main conduit: 800 feet long; 12 inches diameter; cast iron.
Description of distributing reservoir: 16 feet deep; 130 feet 7½ inches square on top, 87 feet square on bottom; a dividing embankment across the middle, with 12-inch inlets.
Sizes of distributing mains: 8, 6, 4, and 2 inches.
Available head: 50 to 75 feet.
Total length of distributing mains: 24,000 feet.
Number of water-takers: 261.
Consumption of water: 40 gallons per head per day (estimated).
First cost of water-works: $80,000.
Average annual cost of maintenance and repairs: $300.
Number of fire-plugs: 10.
Design and dimensions of pump and water-plungers: Built by I. S. Cassin, Philadelphia, Pennsylvania; plain plungers; 7 inches diameter; 48 inches stroke; 12 strokes per minute (average); pump-barrels, 7 inches diameter.
Description of force-main: 4,800 feet long, 8 inches diameter; 2,450 feet long, 6 inches diameter; difference of level is 248.8 feet.
Description of water-valves: Brass.
Kind of power used: Steam and water.
Description of water-wheel: Leffel turbine; 35 inches diameter; 10¾ feet head; 124 revolutions per minute; about 350 gallons required to lift 1 gallon to reservoir.
Description of boiler: Upright tubular; 20 horse-power.
Remarks: The disadvantage of pumping direct to mains is that the water is muddy after rains.

POTTSTOWN:
Population: 5,305 inhabitants.
Name of corporation: Pottstown Gas and Water Company (private).
Water obtained from: Schuylkill river.
Total area of water-shed available: 2,000 square miles.
Water first introduced: In 1870.
Description of main conduit: 5,000 feet long; 10 inches diameter; head, 140 feet.
Description of distributing reservoir: Built in two sections, nearly square, on a hill; partly excavated and partly embankment; puddled with clay; lined with brick laid in cement and cemented over; capacity, 1,600,000 gallons; water not filtered, but run through a screen.
Sizes of distributing mains: 8, 6, and 4 inches.
Available head: 90 to 120 feet.
Total length of distributing mains: 7 miles.
Number of water-takers: 400.
First cost of water-works: About $85,000.
Average annual cost of maintenance and repairs: About $3,000.
Number of fire-plugs: 45.
Design and dimensions of pump and water-plungers: Henderson pump, built by Philadelphia Hydraulic Works; two plain plungers, 8 inches diameter; 24 inches stroke; 25 strokes per minute; pump-barrel, 8 inches diameter.
Time pump is run: 4 hours per week.
Description of force-main: About 65 pounds pressure on pump.
Description of water-valves: Brass.
Kind of power used: Steam.
Description of boilers: Tubular.
Description of engine: Condensing; cylinder, 10 inches diameter; 24 inches stroke; 25 strokes per minute.
Cost of engine and pump: $11,000.
Remarks: The advantage of pumping direct to mains is reduction of expense for pipes; the disadvantage consists mainly in this that consumers are supplied with muddy water from river.

TENNESSEE.

MEMPHIS:
Population: 33,592 inhabitants.
Name of corporation: Memphis Water Company (private).
Water obtained from: Wolf river.
Water first introduced: In 1873.
Description of distributing reservoir: Earthen embankment, with puddle face and brick riprap; 16 feet deep; slopes, 1½ to 1; capacity, 3,500,000 gallons.
Sizes of distributing mains: 20, 18, 16, 14, 12, 10, 8, 6, 4, and 3 inches.
Total length of distributing mains: 28 miles.
Number of water-takers: 2,759.
Consumption of water: 4,500,000 gallons per day.
First cost of water-works: $450,000.
Average annual cost of maintenance and repairs: $20,000.
Number of fire-plugs: 184.
Design and dimensions of pumps and water-plungers: Holly, in 1873; gang of 8 operated by 2-cylinder engine; 8 plain single-acting lift-plungers; 20 inches diameter; 24 inches stroke; 15 strokes per minute; pump-barrel, 20 by 36 inches.
Time pumps are run: Constantly.
Description of force-main: 2 miles long; 20 inches diameter; cast iron.
Description of water-valves: Rubber disk; 16 inches; 3 inches lift.
Kind of power used: Steam.
Description of boilers: Three multitubular; 16 feet long; 70 inches diameter; 120 3-inch tubes in each; 60 to 70 pounds pressure; fuel, best soft coal.

MEMPHIS—Continued.

Description of engine: Non-condensing; 2 cylinders; 20 inches diameter; 33 inches stroke; 37½ strokes per minute; slide-valves.
Duty of engine: 32,000,000 foot-pounds, daily.
Remarks: New engines are being built.

TEXAS.

SAN ANTONIO:

Population: 20,550.
Name of corporation: San Antonio Water-Works Company (private).
Water obtained from: San Antonio river.
Capacity of reservoir: 5,000,000 gallons.
Cost of dam: $150,000.
Water first introduced: In July, 1878.
Description of main conduit: 2 miles and 4,100 feet long; 12 inches diameter; cast iron; head, 154 feet (average).
Description of distributing reservoir: 200 feet square; 20 feet deep.
Sizes of distributing mains: 10, 8, and 6 inches.
Available head: 60 pounds (average).
Total length of distributing mains: About 12 miles.
Number of water-takers: 565.
Consumption of water: 800,000 gallons per day (estimated).
First cost of water-works: $125,000.
Average annual cost of maintenance and repairs: About $10,000.
Number of fire-plugs: 100.
Design and dimension of pump and water-plungers: Built by Worthington, New York; two pair plungers; 14 inches diameter; 10½ inches stroke; 40 strokes per minute; pump-barrels, 14 by 10½ inches.
Time pump is run: About 14 hours per day.
Description of water-valves: Rubber; 5 inches diameter.
Kind of power used: Water.
Description of water-wheels: Two, 72 inches diameter; Eclipse double turbines; built by Stillwell & Beirce, Dayton, Ohio; 8 feet head; 30 revolutions per minute.

770

WISCONSIN.

MENOMONEE:

Population: 4,177 inhabitants.
Name of corporation: The Knapp, Stout & Co. Company (private).
Water obtained from: Red Cedar river.
Total area of water-shed available: 1,620 square miles.
Capacity of reservoir: 152,000 gallons.
Character and dimensions of dam: 400 feet long; 11 feet head; across Red Cedar river.
Cost of dam: $10,000.
Water first introduced: In 1876.
Description of main conduit: Ayerault wooden pipe; 400 feet, 2,500 feet, and 600 feet long; 8, 4, and 6 inches diameter, respectively.
Discharging capacity: 750 gallons per minute; head, 100 feet and 150 feet.
Description of distributing reservoir: Brick and stone; set on a hill 185 feet high; 24 by 60 feet and 14 feet deep; covered.
Sizes of distributing mains: 8, 6, and 4 inches.
Available head: 100 feet (average).
Total length of distributing mains: 3,900 feet.
First cost of water-works: $10,000.
Average annual cost of maintenance and repairs: $150.
Number of fire-plugs: 14.
Design and dimensions of pump and water-plungers: Built by Worthington, Pittsburgh, Pennsylvania, 1876; duplex; two plain plungers; 10 by 7 inches; 80 strokes per minute; pump-barrel, 20 by 20 inches and 16 inches.
Time pump is run: Six hours per day.
Time spent in repairs: 48 hours per year.
Description of force-main: 1,400 feet long; 80 pounds pressure on pump.
Description of water-valves: Rubber; 4 inches diameter. One Eclipse, 72 inches diameter; built by Stillwell & Beirce; vents 303 square inches water; 12 feet head; 20 revolutions per minute.
Kind of power used; Water.

WATER-WORKS EMPLOYING SYSTEM OF PUMPING TO STAND-PIPE AND DISTRIBUTING MAINS.

ILLINOIS.

WILMINGTON:
- Population: 1,872 inhabitants.
- Style of corporation: Municipal.
- Water obtained from: Branch of Kankakee river.
- Character and dimensions of dams: Across river, 1,006 feet long, 16 feet high; across branch, 700 feet long, 5 feet high.
- Cost of dams: $400,000.
- Water first introduced: In 1877.
- Description of main conduit: 6 inches diameter; cast iron.
- Sizes of distributing mains: 6 and 4 inches.
- Total length of distributing mains: About 5,000 feet.
- First cost of water-works: $5,000.
- Number of fire-plugs: 3.
- Design and dimensions of pumps and water-plungers: Holly, No. 7; two rotary pumps, Nos. 4 and 7.
- Kind of power used: Water.
- Description of water-wheel: Leffel turbine; 54 inches diameter; 8 feet head; 75 revolutions per minute.
- Remarks: Water only used for fire purposes.

IOWA.

CLINTON:
- Population: 9,052 inhabitants.
- Name of corporation: Clinton Water-Works Company (private).
- Water obtained from: Mississippi river.
- Water first introduced: In 1874.
- Description of stand-pipe: 100 feet high; contains 13,500 gallons.
- Sizes of distributing mains: 16 to 4 inches.
- Available head: 100 feet (average).
- Total length of distributing mains: 8 miles.
- Number of water-takers: 352.
- Consumption of water: 550,000 gallons per day (estimated).
- First cost of water-works: $120,000.
- Average annual cost of maintenance and repairs: $4,500.
- Filtering apparatus: Use boxes filled with sand and gravel; cleaned twice a year.

CLINTON—Continued.
- Number of fire-plugs: 85.
- Design and dimensions of pumps and water-plungers: Built by Cope & Maxwell, Ohio, in 1874; 3 plain plungers, 10 inches diameter; 28 inches stroke; 33 strokes per minute; pump-barrel, 10 by 28 inches. Pressure on pumps—domestic use, 50 pounds; for fire, 100 pounds.
- Time pumps are run: One constantly.
- Description of water-valves: Rubber; 8 inches diameter; 2 inches lift.
- Kind of power used: Steam.
- Description of boilers: Two; 16 feet long; 5 feet diameter; 13 6-inch flues.
- Description of engine: Non-condensing; cylinder, 16 inches diameter; 28 inches stroke.
- Cost of engine and pumps: $13,500.

TEXAS.

HOUSTON:
- Population: 16,513 inhabitants.
- Name of corporation: Houston Water-Works Company (private).
- Water obtained from: Buffalo bayou.
- Character and dimensions of dam: Small one below works to keep out tide-water from bay.
- Water first introduced: April, 1879.
- Description of stand-pipe: 86 feet high; 20 feet diameter.
- Sizes of distributing mains: 12, 10, 8, 6, and 4 inches.
- Available head: 30 pounds (average); water-supply deficient when it is low in stand-pipe.
- Total length of distributing mains: 13 miles.
- Number of water-takers: 350.
- Consumption of water: 250,000 gallons per day (estimated).
- First cost of water-works: $75,000.
- Average annual cost of maintenance and repairs: From $5,000 to $10,000, including extensions.
- Number of fire-plugs: 91.
- Design and dimensions of pump and water-plungers: Built by H. R. Worthington, New York.

WATER-WORKS EMPLOYING THE GRAVITY SYSTEM AND PUMPING TO DISTRIBUTING RESERVOIR AND STAND-PIPE.

DISTRICT OF COLUMBIA.

WASHINGTON:

Population: 147,293 inhabitants.

Style of corporation: Owned by United States and District of Columbia.

Water obtained from: Potomac river.

Character and dimensions of dam: One at Great Falls; built of rubble and solid masonry.

Cost of dam: $3,784,546.72 expended by the United States; $1,313,315.17 expended by Washington; $40,000 expended by Georgetown.

Water first introduced: In 1858.

Description of main conduit: 9 miles long; 9 feet diameter; brick.

Discharging capacity: 30,000,000 per 24 hours; head, 145 feet (average).

Description of stand-pipe: 52 feet high; 32 feet diameter.

Sizes of distributing mains: 36, 30, and 12 inches.

Water-supply: Deficient.

Total length of distributing mains: 175 miles and 3,777½ feet.

WASHINGTON—Continued.

Consumption of water: 26,000,000 gallons per day, or 176 gallons per head per day (estimated).

Average annual cost of maintenance and repairs: $70,000.

Number of fire-plugs: 825.

Design and dimensions of pumps and water-plungers: One Knowles; one Blake, built in New York; 3 plain plungers; 15 inches diameter; 24 inches stroke; 36 strokes per minute.

Time pumps are run: Constantly.

Time spent in repairs: About 180 hours per year.

Description of force-main: 3,000 feet long.

Description of water-valves: Rubber; 4 inches size; 2½ inches lift.

Kind of power used: Steam.

Description of boilers: 25 pounds pressure; fuel, Cumberland coal.

Description of engines: Condensing compound; 36 strokes per minute; slide and oval valves operated by steam; condenser, 6 by 12.

Cost of engines and pumps: $12,000.

WATER-WORKS EMPLOYING THE GRAVITY SYSTEM AND PUMPING TO DISTRIBUTING RESERVOIR AND MAINS.

MISSOURI.

KANSAS CITY:

Population: 55,785 inhabitants.
Name of corporation: National Water-Works Company of New York (private).
Water obtained from: Kansas river.
Water first introduced: In 1874.
Description of main conduit: 1,350 feet long; 24 inches diameter; siphon-pipe.
Discharging capacity: About 8,000,000 gallons per day.
Description of distributing reservoir: Clay embankment laid in 1-foot depths and rolled; bottom, concrete, 9 inches thick; sides paved with limestone 12 to 18 inches thick; dimensions, 300 by 330 feet; water, 21 feet deep; elevation flow-line, 236 feet; capacity, 10,000,000 gallons.
Sizes of distributing mains: 15, 12, 10, 8, 6, and 4 inches.
Available head: 60 to 250 feet.
Total length of distributing mains: About 25 miles.
Number of water-takers: About 1,700.
Consumption of water: 2,070,000 gallons per day (exact).
Average annual cost of maintenance and repairs: $23,000.
Filtering apparatus: Water stands two or three days in subsiding reservoir to allow sediment to settle, then passes through wall of finely broken stone; cleansed twice a year; capacity, 10,000,000 gallons.
Number of fire-plugs: 265.
Design and dimensions of pumps and water-plungers: Built by the Holly Manufacturing Company, Lockport, New York; part piston and part plungers; two, 15½ inches diameter, 30 inches stroke; four, 10 inches diameter, 30 inches stroke; four, 7¾ inches diameter, 22 inches stroke; four, 10½ inches diameter, 33 inches stroke; two, 21 inches diameter, 34 inches stroke; 20 to 40 strokes per minute.
Time pumps are run: Constantly.
Description of force-mains; One, 2,390 feet, 20 inches diameter, 90 pounds pressure on pumps; the other, 4,567 feet long, 20 inches diameter, 135 pounds pressure on pumps.
Description of water-valves: Low-service, rubber disks, 5½ inches diameter, ⅜ inch lift; high-service, brass breast, 3 by 10 inches, ⅝ inch lift; brass puppet, rubber seats, 1¼ inch diameter, 1¼ inch lift.
Kind of power used: Steam.
Description of boilers: Return tubular; 16 feet long; 5½ feet diameter; 52 3½ inch flues; grate surface, 22 feet each; 100 square feet coal surface.
Description of engines: One set compound condensing, 21 by 30 inches each; one single condensing, 16 by 27 inches; one set of 4 compound condensing, 27 by 33 inches each; 20 to 40 strokes per minute; slide puppet-valves; cut-off variable, on top of steam-chest; two single-acting air-pumps to each set; jet-condenser.

KANSAS CITY—Continued.

Duty of engines: Old, 10,000,000 foot-pounds guaranteed; new, 8,000,000 foot-pounds guaranteed.
Remarks: The advantage of pumping to mains consists in the supplying of heights not covered by reservoir; the disadvantage is that constant action is required.

NEW JERSEY.

LAMBERTVILLE:

Population: 4,183 inhabitants.
Name of corporation: Lambertville Water Company (private).
Water obtained from: Trap-dike (Goat hill) and Delaware river.
Total area of water-shed available: 1,000 acres.
Capacity of reservoir: 6,097,577 gallons.
Character and dimensions of dam: 200 feet long; 9 feet high.
Cost of dam: $22,471 55.
Water first introduced: November, 1878.
Available head: 164 feet (average).
Number of water-takers: 111.
Description of water-valves: Rubber.
Kind of power used: Steam.
Description of boilers: Tubular; fuel, anthracite, Jeddo mines, Lehigh.
Cost of engine and pump: $1,656 25.
Remarks: The advantage of pumping to mains is that when water is required for fire or for house use it is received quickly.—Vegetable matter is troublesome in reservoir; water otherwise good.

NEW YORK.

SYRACUSE:

Population: 51,792 inhabitants.
Name of corporation: Syracuse Water-Works (private).
Water obtained from: Brooks, springs, and creek.
Character and dimensions of dam: Earth; back slope, 2½ to 1; front slope, 2 to 1; width on top, 15 feet; front slope faced 15 inches dry wall, backed with 9-inch lining; puddle wall in center, 6 feet wide on top, increasing 11 inches, 6 feet vertical depth.
Water first introduced: In 1849.
Sizes of distributing mains: 30, 24, 12, 10, 8, 6, and 4 inches.
Available head: 122 to 165 feet.
Total length of distributing mains: 40 miles.
Number of water-takers: 1,125.
Consumption of water: 4,000,000 gallons per day (average).
First cost of water-works: $605,000.

SYRACUSE—Continued.

Average annual cost of maintenance and repairs: $13,000.

Number of fire-plugs: 270.

Design and dimensions of pump and water-plungers: Two plain, hollow, air-tight plungers; 30 inches diameter; 50 inches stroke; 25 strokes per minute; pump-barrel, 36 inches diameter.

Time pump is run: 8 hours per day.

Description of water-valves: Rubber; 10 inches diameter; 1¼ inch lift; in chambers above and below plungers.

Kind of power used: Steam.

774

SYRACUSE—Continued.

Description of boilers: Horizontal tubular; 16 feet long; 5 feet diameter; 60 4-inch tubes; 50 pounds pressure; evaporation, 7 pounds of water to 1 pound of coal.

Description of engines: Duplex compound condensing; 2 high-pressure cylinders, 29 inches diameter; 2 low-pressure cylinders, 50¼ inches diameter; 50 inches stroke; 25 strokes per minute; balance D-valve, operated by opposite engine; jet-condenser; 4 air-pumps, 23 inches diameter, 24 inches stroke, bucket type.

Duty of engines: 52,000,000 foot-pounds, daily.

WATER-WORKS EMPLOYING THE GRAVITY SYSTEM AND PUMPING TO STAND-PIPE AND DIRECT INTO DISTRIBUTING MAINS.

PENNSYLVANIA.

TIOGA:

Population: 520 inhabitants.
Name of corporation: T. A. & C. H. Wickham (private).
Water obtained from: Bently creek.
Total area of water-shed available: About 1 square mile.
Capacity of reservoir: 12,000,000 gallons.
Character and dimensions of dam: On creek; 270 feet long on top; 30 feet high; greatest depth, 25 feet; made of earth, with clay puddling starting from sheet-piling of foundation.
Cost of dam and reservoir: Dam, $2,100; reservoir, $3,500.
Water first introduced: December, 1874.
Description of main conduit: 6, 4, and 3 inches diameter; Wyckoff's patent wooden pipe.
Discharging capacity: 500 gallons per minute; head, 113.7 feet (average).

TIOGA—Continued.

Description of distributing reservoir: Excavated; size, 80 by 90 feet at water-line; lined with masonry wall faced with brick; slopes, 1 to 4 and 1 to 2½; depth of water over discharge-pipe, 16 feet; capacity, 750,000 gallons.
Sizes of distributing mains: 6, 4, and 3 inches.
Available head: 210 feet (average).
Total length of distributing mains: 15,500 feet.
Number of water-takers: 63.
Consumption of water: 250,000 gallons per day (estimated).
First cost of water-works $20,000.
Average annual cost of maintenance and repairs: $20.
Filtering apparatus: One set galleries at reservoir; sand and gravel; cleaning depends on storms.
Number of fire-plugs: 14.
Design and dimensions of pumps and water-plungers: One La France, Elmira, New York; pumping done outside.

WATER-WORKS EMPLOYING SYSTEM OF PUMPING TO DISTRIBUTING RESERVOIR, STAND-PIPE, AND MAINS.

MASSACHUSETTS.

NEW BEDFORD:

Population: 26,845 inhabitants.
Name of corporation: New Bedford Water-Works (municipal).
Water obtained from: Acushnet river.
Total area of water-shed available: About 3,300 acres.
Capacity of reservoir: About 300,000,000 gallons.
Character and dimensions of dam: 600 feet long; 20 feet wide; slopes, 2 to 1; top, 4 feet above high-water; 15 feet deep; gravel puddle-wall, and loam cut and cross-cut with spade.
Cost of dam: $18,845 24; improvements, $45,556 72.
Water first introduced: January, 1870.
Description of main conduit: 5⅝ miles long; egg shape; 3 feet by 4 feet; brick.
Discharging capacity: 11,664,000 gallons; head, 8 feet 8 inches (average).
Description of distributing reservoir: Rectangular earth embankment; 15 feet wide on top; slopes, 2 to 1; 17 feet deep; water-surface, 3½ acres; capacity, 14,000,000 gallons.
Sizes of distributing mains: 24 to 4 inches.
Available head: 90 feet, or 62 pounds (average); water-supply deficient.
Total length of distributing mains: 42.27 miles.
Number of water-takers: 3,798.
First cost of water-works: $526,000.
Average annual cost of maintenance and repairs: About $14,000.
Number of fire-plugs: 295.
Design and dimensions of pumps and water-plungers: Two. No. 1, McAlpine; Morgan Iron Works, New York, in 1868–'69; single-acting; 2 pistons; 28 inches diameter; 4 feet 8 inches stroke; 28 strokes per minute; pump-barrel, 28 inches diameter. No. 2, Worthington, New York, 1873–'74; 2 plain plungers, 17⅓ inches diameter; 36 inches stroke; 30 strokes per minute; pump-barrel, 17⅓ inches diameter.
Time pumps are run: No. 1, 3,060 hours; No. 2, 281 hours in 1880.
Time spent in repairs: About 200 hours per year.
Description of force-main: 2,200 feet long; 16 inches diameter; head, 122 feet on pumps.
Description of water-valves: No. 1, butterfly, 12 by 27 inches; No. 2, rubber disk, 7 inches diameter.
Kind of power used: Steam.
Description of boilers. Horizontal return tubular; 18 feet long, 6 feet diameter; 90 3½-inch tubes in each; 30 pounds pressure; fuel, Wilkesbarre broken coal.
Description of engines: No. 1, condensing, simple; cylinder, 36 inches diameter; 8 feet stroke; 27 strokes per minute; puppet-valve, Sickles cut-off; air-pump, 27 by 34 inches; jet condenser, 5 by 4 feet. No. 2, condensing compound; high-pressure cylinder, 21⅝ inches diameter; low-pressure cylinder, 36 inches diameter; 36 inches stroke; 60 strokes per minute. Worthington valves and jet-condenser.
Cost of engines and pumps: No. 1, $37,457 33; No. 2, $17,000.

NEW BEDFORD—Continued.

Duty of engines: No. 1, 45,159,704 foot-pounds, daily; 60,000,000 foot-pounds guaranteed. No. 2, 34,050,875 foot-pounds, daily.
Remarks: A bed of peat under reservoir discolors water slightly.

PENNSYLVANIA.

CATASAUQUA:

Population: 3,065 inhabitants.
Name of corporation: Crane Iron Company (private).
Water obtained from: Lehigh river.
Water first introduced: In 1843.
Description of main conduit: Open feeder, 1,200 feet long; 25 feet wide; 7 feet deep.
Description of distributing reservoir and stand-pipe: 50 feet square; 12 feet deep; earthen banks; brick, laid in cement; stand-pipe, 120 feet high, 48 inches diameter at bottom, 36 inches diameter at top.
Sizes of distributing mains: 12, 10, 8 inches.
Available head: 15 to 40 pounds.
Total length of distributing mains: 2 miles.
Number of water-takers: 258.
First cost of water-works: $6,300.
Average annual cost of maintenance and repairs: $100.
Number of fire-plugs: 3.
Design and dimensions of pump and water-plungers: Home made; two plain double-acting pistons; 8 inches diameter; 36 inches stroke; 8 strokes per minute; pump-barrel, 8 inches diameter.
Time pump is run: Constantly.
Description of force-main: 100 feet long; 65 pounds pressure on pumps.
Description of water-valves: Gum disk; size, 11¼ inches; lift, 1 inch.
Kind of power used: Water.
Description of water-wheel: 12 feet diameter; 3 feet head; 24 revolutions per minute.

ERIE:

Population: 27,737 inhabitants.
Name of corporation: City Water-Works (municipal).
Water obtained from: Lake Erie.
Cost of dams: $702,391 58.
Water first introduced: In 1868.
Description of main conduit: 1,400 feet long.
Description of distributing reservoir and stand-pipe: 28 feet deep; capacity, 33,000,000 gallons; stand-pipe, 250 feet high; made of iron, surrounded by a brick tower.
Sizes of distributing mains: 20, 12, 6, and 4 inches.
Available head: 100 to 200 feet.
Total length of distributing mains: 35 miles.
Number of water-takers: About 3,500.
Consumption of water: 77 gallons per head.
First cost of water-works: $675,000.

ERIE—Continued.

Average annual cost of maintenance and repairs: $19,397 45.
Number of fire-plugs: 130.
Design and dimensions of pumps and water-plungers: Built by West Engine Company, Norristown, Pennsylvania; 10 strokes per minute; pump-barrels, 10 feet by 21 inches.
Time pumps are run: Constantly.
Description of force-main: 2 miles long; 20 inches diameter.
Description of water-valves: Crown; 27 inches diameter; receiving-lift, 2 inches; delivery-lift, 1½ inch.

ERIE—Continued.

Kind of power used: Steam.
Description of boilers: Horizontal tubular; 60 pounds pressure; evaporation about 6 to 1; fuel, bituminous coal.
Description of engine: Condensing simple-acting; 60 inches diameter; 120 inches stroke; 10 strokes per minute; crown-valves operated by springs; air-pump single; jet-condenser; volume of air-pump, 25.9 feet.
Cost of engines and pumps: $55,000.
Duty of engine: 24,628,000 foot-pounds, daily.

777